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Monitoring Methods Development in the Beaumont-Lake Charles Area

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INTERIM REPORT ON MONITORING METHODS DEVELOPMENT IN THE BEAUMONT-LAKE CHARLES AREA

U.S. Environmental Protection Agency
Office of Research and Development
Washington, D.C.

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In 1978, the U.S. Environmental Protection Agency initiated a study in the Beaumont, Texas-Lake Charles, Louisiana area (BLCA) as a preliminary step to develop, demonstrate and test methods for monitoring levels of chemicals, primarily in air and water, and to measure effects of the atmosphere on indicator organisms, all within a defined geographic area. The BLCA was selected because of its established petrochemical industries, and its residential, commercial, transportation and agricultural character. The selected study area includes Jefferson and Orange Counties in Texas and Calcasieu and Cameron Parishes in Louisiana.

KEYWORDS: *Air pollution, *Water pollution, *Lake Charles.

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DISCLAIMER

This is a measurement methods development study. The results of this work and companion studies will provide the tools needed to accurately judge the quality of the environment and to assess more fully the long-term implications of chemicals in our environment.

The developmental nature of the methods employed in the study limits the utility of the environmental data that have been produced. Although these data have been reviewed by the investigators and by a panel of EPA scientists, they have not yet been reviewed by experts outside the Agency. As such, the data should be viewed as provisional and subject to reinterpretation based on the forthcoming external review.

No effort was made to determine possible health effects of chemicals found in the environment. None of the measured substances exceeded levels known to cause acute health effects; nor do we presently have any evidence that long-term exposures to such levels might cause adverse chronic effects. Further studies by EPA and others of the scientific community will be directed toward assessing the long-term health implications of exposure to such low levels of environmental pollutants.

Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

ABSTRACT

In 1978, the U.S. Environmental Protection Agency (EPA) initiated a study in the Beaumont, Texas-Lake Charles, Louisiana area (BLCA) as a preliminary step to develop, demonstrate and test methods for monitoring levels of chemicals, primarily in air and water, and to measure effects of the atmosphere on indicator organisms, all within a defined geographic area. The BLCA was selected because of its established petrochemical industries, and its residential, commercial, transportation and agricultural character. The selected study area includes Jefferson and Orange Counties in Texas and Calcasieu and Cameron Parishes in Louisiana.

Major areas of investigation in this study included:

- Collection of relevant background information on the study area including geographical and climatological information, industrial production and discharge data and other information related to the study
- Preliminary source investigations at selected major industries
- Evaluation of new chemical methods for detection of environmental agents and methods for the detection of the biological effects of such agents.

The following methods and systems were tested as part of these activities:

- Three methods for collecting organic gases in air
- A massive air sampler (MAS) for collecting large amounts of particles in air and subsequent mutagenesis testing with Salmonella
- A scheme for extracting and chemically fractionating organic material collected by the MAS
- A system for testing each chemical fraction for mutagenicity using Salmonella
- Methods for detecting direct atmospheric effects on mutation frequencies of Tradescantia and Zea mays
- Methods for personal monitoring: measuring levels of chemicals in individual air, breath, body fluids, and drinking water.

Over 50 ambient air samples, 20 water samples, and a few fish, sediment, and soil samples were collected and analyzed for organic and inorganic compounds. Several different laboratories within EPA as well as academic institutions conducted collection and analyses of these samples.

A total of about 200 organic compounds were identified in both the Beaumont and Lake Charles atmospheres. Of 400 quantified values for 10 to 20 chemicals, 300 were above trace levels. The methods employed appeared capable of identifying those compounds of possible interest in future monitoring efforts.

Elevated trihalomethane levels were found in tap water samples from three of the eight drinking water supplies analyzed. Elevated mercury levels were found in drinking water taken from the three Louisiana systems sampled.

Screening studies of possible industrial pollutant sources were initiated to obtain desired chemical substances data and overview information on the status of compliance of the facility with applicable air and water pollution standards and hazardous waste disposal regulations.

The collection of data for environmental or health assessment was not the objective of this preliminary field effort. The limited data generated during this preliminary study are not of sufficient detail or comprehensive nature to accurately characterize ambient quality in relation to chemicals for the BLCA as a whole, to determine the extent of population exposure to the chemicals, nor to link environmental quality with health effects. For most organic compounds, the state-of-the-art in toxicology has not yet produced sufficient evidence to relate adverse human health effects to specific types and levels of chemical exposure. Review and analysis of the sampling results, however, may be useful in more clearly defining future needs for research, monitoring and investigation in the Beaumont-Lake Charles area. Data collected as part of this study and in ongoing activities in the BLCA will be reported in the scientific literature as analyses are completed.

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SECTION 1

INTRODUCTION

In 1978, EPA decided to conduct a study in the Beaumont, Texas-Lake Charles, Louisiana area (BLCA) as a preliminary step to develop, demonstrate and establish methods for monitoring exposure to chemical substances through the major media in a defined geographic area. In addition, the information from this study could be used to: (1) design further monitoring studies to develop a reliable data base, (2) provide a provisional estimate of the levels of exposure to specific substances that could be experienced by residents within a study area, (3) highlight needs for additional regulatory mechanisms where none exist for problem pollutants, and (4) ensure compliance with existing regulatory requirements. Three EPA organizations conducted the study in a joint effort--the Office of Research and Development (ORD), the National Enforcement Investigation Center (NEIC), and EPA's regional office in Dallas, Texas (Region 6).

Study activities centered around four areas:

- Source investigations--collecting industrial production data and monitoring emissions and effluents from selected industrial plants
- Ambient measurements--sampling ambient air for vapor-phase organics and particulate matter, analyzing drinking water and surface waters, and testing food
- Biological monitoring of environmental quality--microbial mutagenesis bioassay of particulate organics and two plant bioassays for biological activity
- Personal exposure assessment methods--testing of personal air quality monitors to measure breathing level air, and analysis of body fluids (breath, blood and urine) and drinking water.

The details of the first two study segments are described in the METHODS section. The results of the latter two study segments are still undergoing analysis and, therefore, will not be treated in detail in this interim report. Brief discussions of these two study segments follow.

In the third study segment, three bioassays were evaluated for their applicability for monitoring environmental quality: the Salmonella/liver microsome assay, the Tradescantia stamen hair assay and the Zea mays pollen grain assay. The Salmonella/liver microsome assay was used for examining the mutagenicity of organic components extracted from atmospheric particles collected by a massive volume air sampler. The Tradescantia stamen hair

assay was performed in two ways: cuttings of Tradescantia were exposed to ambient air in exposure chambers built into a mobile van, or the plants were maintained in pots in the field for direct exposure to the atmosphere. The third assay involved growing Zea mays in pots in the field and analyzing pollen grains for mutation. The data collected in these studies will be reported in the scientific literature as analyses are completed.

Personal monitoring methods were tested on two occasions. In December 1980, 11 student volunteers from Lamar University in Beaumont, Texas gave blood samples to be analyzed for volatile organic compounds by the University of Miami Medical School using a new analytical procedure developed by that group (Peoples et al. 1979). In March 1980, a second set of 11 Lamar University volunteers submitted to a battery of personal monitoring techniques. Each volunteer carried a personal air quality monitor consisting of a small pump and a Tenax cartridge. After an 8-h exposure, the students gave a 15-minute breath sample, also collected on Tenax cartridges. Each student collected drinking water samples during the 8-h exposure period. Blood and urine samples were taken at the end of the exposure period. The air, water, breath, blood and urine samples were then analyzed for volatile organic compounds by Research Triangle Institute. Duplicate blood samples were analyzed by the Univeristy of Miami Medical School. In June 1980, identical procedures were carried out on six volunteers from another university outside the study area for comparison purposes. The results of these studies are not yet completely analyzed and on completion will be submitted for scientific publication.

The main objective of these research activities was to develop and evaluate several field measurement techniques and analytical procedures, and to refine analytical capabilities of participating laboratories. Data collection was incidental to development of sampling methodologies and protocols, but can be useful in guiding the effective utilization of resources in any subsequent stages of this research.

A Subcommittee on Quality Assurance, which consisted of representatives from EPA Headquarters, EPA Region 6, NEIC, and the various environmental monitoring laboratories, was responsible for selection of methods to be employed in all segments of the Beaumont-Lake Charles study. Selected protocols were circulated among experts from these organizations for comment.

The findings of this Beaumont-Lake Charles study are being used in planning future national research strategies, developing measurement methods, identifying sources, and determining exposure ranges that can result in the development of appropriate control strategies and regulations. In addition, the information is being used at the Regional level to support ongoing program activities. For example, industrial inspections and aerial photography have contributed information relevant to the uncontrolled hazardous waste site program. Results of this study also can be used to ensure compliance with existing regulatory requirements and assist in the development and issuance of new requirements for the second round of NPDES permits for BAT (Best Available Technology economically achievable) toxics control.

SECTION 2

CONCLUSIONS

Conclusions that can be drawn from results of the Beaumont-Lake Charles study are as follows:

- The Tenax method was successful in collecting a large number of vapor-phase organics. Qualitative identification of organic vapors using this method was accomplished with substantial agreement among participating laboratories. However, Tenax samples degrade and will not yield quantitative data after 3 to 4 weeks of storage at -20°C.

- Analysis by a single laboratory of duplicate Tenax samples from both Lake Charles and Beaumont indicated relative standard deviations ranging from 5 to 50 percent depending on the chemical analyzed.

- Compounds observed to be at high frequencies of occurrence (in more than 80 percent of the samples) in both Beaumont and Lake Charles were benzene, toluene, cyclohexane, methylcyclohexane, 2-methylpentane, 3-methylpentane, 2-methylhexane, 3-methylhexane, and hexane.

- Quantitative values for many of the detectable vapor-phase organics were determined. These values are estimates based on best existing methodology, but they depend on several assumptions associated with the collection methods and should be treated as provisional. Concentrations of volatile organics showed extreme variability, with most compounds ranging over several orders of magnitude even when collected from the same location on consecutive days.

- Water samples were collected before treatment and at consumer faucets from drinking water supplies serving about 77 percent of the population in the study area. Two of the groundwater supplies are serving a highly mineralized water that does not meet secondary drinking water recommendations. Several of the groundwater supplies have excess iron and manganese in their source water but only Sulphur and Lake Charles supplies exceed the secondary limits in distributed water. Manganese levels in the Beaumont surface water supply also were found to exceed secondary standards. The levels of inorganics found in these samples do not appear to be of public health significance.

- Trace metal analyses did not indicate corrosion of the distribution system or plumbing, but there was some evidence that asbestos fibers may have entered the water of some supplies in the distribution system. Five of six Louisiana samples exceeded 2 ppb mercury. (These findings have not been repeated in subsequent testing by the State of Louisiana or by EPA, Region 6. Further sampling by Region 6 and by the State is planned.) The information generated regarding asbestos and mercury levels, however, was insufficient to demonstrate definitive trends.

- Sampling of chlorinated surface water and groundwater supplies revealed the presence of trihalomethanes, with several surface water supplies showing levels exceeding the recommended limit of 100 µg/l for this group of contaminants. Additional organic analyses would be required to validate and assess the significance of these findings.

- Analyses of drinking water for organic compounds other than trihalomethanes showed evidence of slight chemical pollution in five of the raw water samples (collected prior to treatment). The organic chemicals 1,2-dichloroethylene, 1,2-dichloroethane, trichloroethylene and tetrachloroethylene were detected in trace levels in tapwater samples from four of these five supplies.

SECTION 3

RECOMMENDATIONS

The recommendations based on the results of the Beaumont-Lake Charles environmental study are as follows:

- Development of standards to establish instrumental response to known amounts of an organic compound is desirable. Without such standards, the accuracy of quantitative estimates cannot be established.

- The Tenax method should be further evaluated in regard to possible interferences from active atmospheric compounds, displacement of one compound by another, and expected recovery efficiencies under variable conditions of collection, transportation, and storage of samples.

- Studies should continue for characterization of the ambient atmosphere to determine the chemicals present, their range of concentrations, dependence on location, meteorology, industrial activity, and other important variables. Particular questions raised by the study include the following:

  - How great is temporal variability?
  - Can data derived from monitoring at fixed sites adequately estimate human exposure?

- Monitoring of drinking water (both source and distribution system), surface water, fish tissue, and sediments should be continued and expanded to determine compliance and adequately characterize the water quality of the study area.

SECTION 4

BACKGROUND INFORMATION FOR THE STUDY

Prior to the initiation of field measurements for organic chemicals conducted in this investigation, it was necessary to develop a detailed profile of the study area. This profile would serve as guidance in sample collection, analyses, and interpretation of the resulting data, as well as in subsequent stages of the study.

CHARACTERIZATION OF THE STUDY AREA

Brief Description of the Study Area (adapted from Gosselink 1979)

The area of study includes the two Texas counties of Jefferson and Orange and the adjoining Louisiana parishes of Calcasieu and Cameron (see Figure 1). This geographical area is known as the Chenier coastal plain, a rich and complex mixture of wetlands, uplands, and open water. Several systems of rivers and lakes cross the Chenier Plain from the north to south and divide it into fairly distinct drainage basins.

The predominant climatological feature of the area is the gulf-wetland interface. The micrometeorology is dominated by a classical coast-sea breeze regime. Winds during the day blow from the Gulf to the north and reverse at night, as the land cools off more rapidly than the water. The area has a warm, humid climate, with seasonal precipitation of approximately 125 cm (50 in.) per year.

There is an abundance of groundwater in the Chenier Plain, the most important source being the Chicot Aquifer, which supplies more than 90 percent of all groundwater pumped in the region. This area is a center of oil and gas production; surface river systems and natural harbors and canals provide easy access to the Gulf of Mexico. Mineral extraction, particularly of oil and gas, is the major industry on the Chenier Plain. The abundance of fresh water in the area is a valuable resource for the manufacturing and refining of petrochemicals.

The Neches-Sabine and Calcasieu basins of the Chenier Plain, where the four counties of the study area are located, have a population of approximately 492,000 people. The major population center consists of three cities: Beaumont, Texas; Lake Charles, Louisiana; and Port Arthur, Texas. The 1970 populations of the above cities are 117,100, 78,500, and 61,300, respectively. This constitutes an urban center of 256,900 people. Fifty-four percent of the people in the study area live in the highly industrialized triangle formed by Beaumont, Lake Charles and Port Arthur.

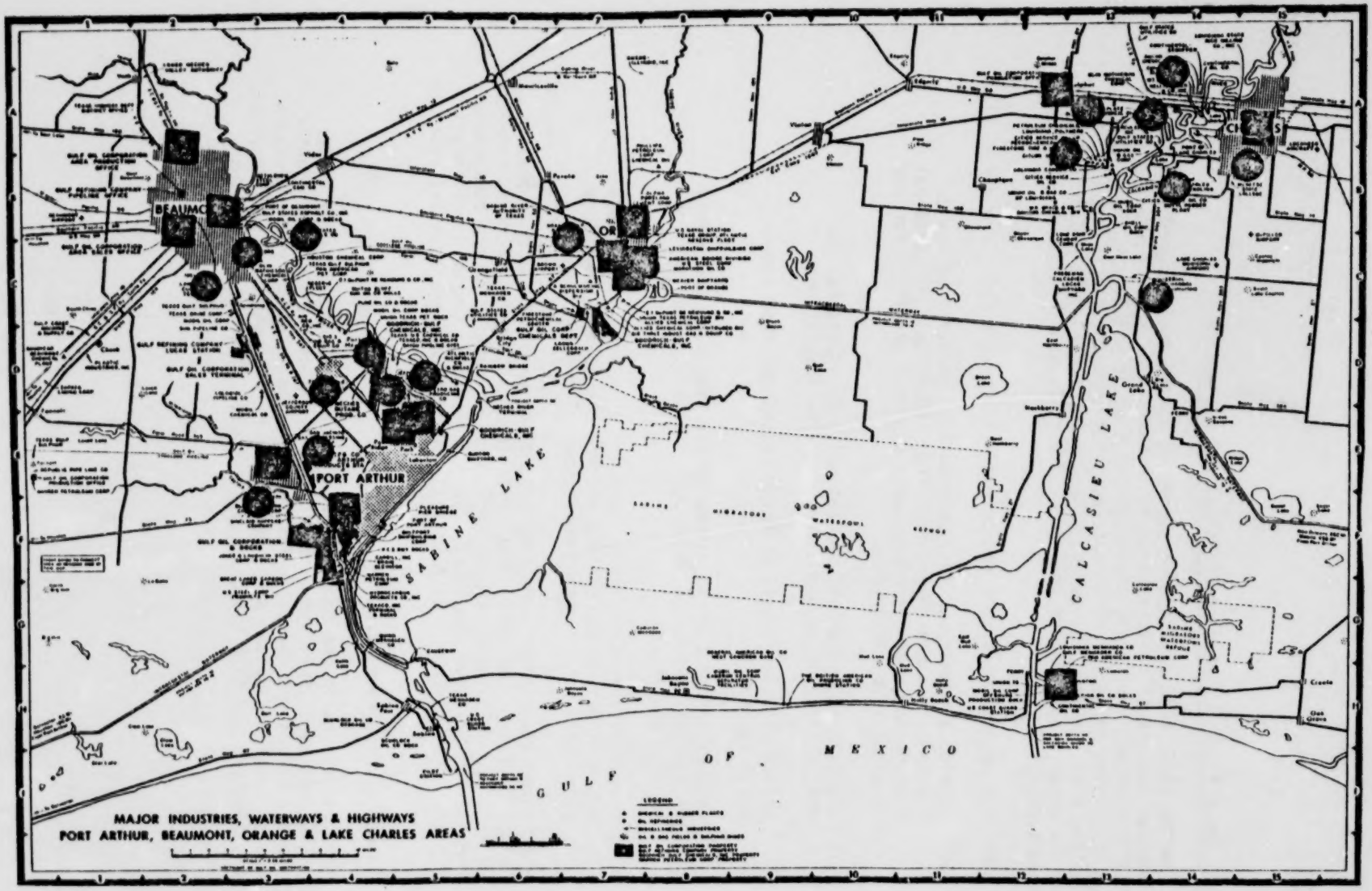


Figure 1. 1979 Beaumont-Lake Charles sampling sites.

Source Identification, Characterization, and Evaluation

During 1979, NEIC conducted a series of activities designed to investigate the various sources of toxic substances in the study area. (Essentially all identification and monitoring of industrial sources was conducted by NEIC.) These activities reflected different levels of investigation related to the significance of the various sources. Results of the evaluations provided input for other activities of this study and to Region 6 pollution abatement program activities.

Specific objectives of the source evaluations were to:

1. Provide a summary of available data on releases of toxic substances to the environment from industrial and municipal sources and from hazardous waste disposal practices for use in other study activities.

2. Identify the potential sources of toxic substances to assist in planning and scheduling site inspections.

3. Define actual releases of toxic substances from industrial sources.

4. Collect information to determine the status of compliance of industrial sources of pollution with existing environmental regulations.

5. Provide evidence of any noncompliance to Region 6 for use and followup on appropriate enforcement actions to secure compliance with existing environmental regulations.

The source evaluations were, and are, being conducted in four phases: compilation of background data, identification of potential sources, screening inspections, and full-scale inspections. A major portion of the background data compilation has been completed, and a preliminary source identification has also been accomplished. No full-scale inspections have been initiated to date.

Compilation of Background Data--

As a first step in the compilation of background data for the study area, NEIC initiated three types of activities in early 1979. These activities were a literature search, a file search, and an aerial reconnaissance. (Details of these activities are given in the METHODS section.) The purpose of the literature and file searches was to locate recorded information

of possible use and to compile any available data on releases of toxic substances to the environment from industrial and municipal sources in the area.

As a result of these efforts, a large volume of information has been compiled on the location, products, processes, air emissions, wastewater discharges, pollution controls, and hazardous waste disposal practices of major industrial facilities. To present this data in summary form, two reports are being prepared covering the Texas and Louisiana portions of the study area, respectively. These summary reports will include descriptions of the study area, summaries of existing air and water quality (with a focus on conventional pollutants, due to the scarcity of data on ambient levels of toxic substances), and a detailed inventory of all known point sources of pollution (conventional and toxic pollutants). Each source's relative potential for releasing toxic substances to the environment through air emissions, wastewater discharges, and disposal of hazardous wastes will be evaluated, and a rating will be assigned based on available data. Significant sources of toxic substances will be selected from the inventory and discussed individually. These primarily will be large chemical, petrochemical and petroleum industrial facilities, although some small industries with high potential for discharge of toxic substances will be included. All known or probable hazardous waste disposal sites will be included. Finalization of these reports has been delayed because of NEIC's assignment to a vigorous role in the national hazardous waste site investigations.

The results of the NEIC data compilation have been used as input information for various other study activities. Location data on industrial plants were used to check the aerial survey atlas prepared by the Environmental Monitoring Systems Laboratory, Las Vegas (EMSL-LV). A field check of the atlas in early December verified locations given by the data. With a few minor revisions, the atlas became a current guide to industrial facilities in the study area. The background data were also used in the preparation of the Center for Environmental Research Information (CERI) annotated bibliography, and also by the University of Texas, School of Public Health in its conduct of epidemiological studies in the study area for the National Cancer Institute.

Subsequent to review of the accumulated information for all industries located in the study area, the next step in the NEIC source evaluation was to initiate screening inspections.

Screening Inspection--

In most cases, data present in EPA files dealt primarily with conventional air and water pollutants. For candidate sources, additional data on the actual release of toxic substances to the environment were desired to meet study objectives. Screening inspections were initiated by NEIC to facilitate the compilation of the needed data. The approach used in the screening inspection was designed to simultaneously obtain the desired toxic substances data and assess the status of compliance of the facility with applicable air and water pollution and hazardous waste disposal regulations.

Prior to visiting the plant, available file information including air, water and hazardous waste permits and permit applications, discharge monitoring reports, emissions inventory questionnaires, and previous inspection reports were reviewed by the inspection team. Process information including raw materials, products, byproducts, and waste streams (air and water) were reviewed. Air and water pollution controls were reviewed and observed.

Wastewater flow measurements at sampling points and procedures were observed. Analytical procedures were reviewed, and the laboratory (including offsite contract laboratories) was inspected for compliance with permit requirements. A general site inspection was made with emphasis on observing any undocumented wastewater discharges, any actual or potential spill conditions, any changes in plant operations from those permitted, and onsite hazardous waste handling and/or disposal practices.

As a screening for toxic substances actually released to the environment, grab samples of wastewaters were taken and analyzed at NEIC for selected toxic substances. (Primarily, priority pollutants and other toxics were expected because of the specific processes involved.) Short-term ambient air samples were taken with Tenax columns onsite in the vicinity of selected process units and offsite downwind of the plant. These were analyzed semiquantitatively for 24 selected volatile organic compounds. All collected samples were preserved and transported according to standard methods or to EPA-approved alternative procedures for analysis by NEIC.

To minimize the resource requirements for conducting screening inspections, the evaluation of processes and the actual sampling of waste streams were necessarily limited. It was intended that the screening inspections would identify any facility where actual releases of toxic substances to the environment were excessive or where conventional pollution from the facility was in substantial noncompliance with applicable regulations.

Full-scale Inspections--

Full-scale inspections differ from screening inspections in several ways. They are more lengthy and resource intensive. Process evaluations are more detailed. Wastewater sampling is conducted according to NPDES permit requirements so that permit violations can be fully documented. Stack sampling of air emissions may also be performed. Samples may be taken of hazardous wastes, and environmental samples may be taken near waste disposal sites, to define any hazard to human health or the environment that may be posed by disposal practices. Document control and chain-of-custody procedures are followed so that all data collected can be used in any subsequent enforcement action. As a result of the expanded sampling and process evaluations, the full-scale investigations require substantially more time than screening inspections, often 1 to 2 weeks versus 1 to 3 days for larger plants.

No full-scale inspections have been conducted to date, as all screening inspections have not been completed, nor have reports been prepared, nor results evaluated. If deemed necessary, full-scale investigations will be scheduled.

Center for Environmental Research Information (CERI) Literature Search

The initial goals of the CERI literature search were twofold: one, to review the material retrieved by the NEIC literature search of data bases that would contain information on the area of study; and two, to collect any additional information to complete the search. Since the NEIC computerized search was performed using only geographical limitations as search terms, additional searches were processed using media- and industry-specific terms. The results of an Office of Research and Development Information System (ORDIS) literature search were also collected. More than 400 citations were retrieved and categorized either as potential primary or background sources of information, or as irrelevant.

Because a goal of this project was to provide information for characterizing the study area, Region 6 and the States of Louisiana and Texas were contacted for NPDES permitting data and for State Water Quality [305(b)] reports for the most recent 3-year period on record. Area 208 water planning agencies provided CERI with point-source inventories and maps that depicted discharge points by river mile. This material could then be superimposed upon Aerial Imagery for an accurate depiction of the area.

An Organic Chemical Producer's Data Base, developed under contract for the Industrial Environmental Research Laboratory, Cincinnati (IERL-Ci), contains current information on chemical production arranged by specific chemical, by poundage, and by manufacturer. To develop as accurate a characterization as possible of plant sites and potential pollution loads, CERI requested that a subroutine module be created to arrange the information in the data base by river basin and sort for industries on the Sabine, the Neches, and and the Calcasieu. This sort was successfully obtained and depicts the petrochemical activity in the area.

The final phase of the literature search was a compilation of all appropriate primary and secondary sources, broken out as such, and listed in annotated bibliography form. The primary sources were each read, indexed by key word, cross-referenced, and synopsized. The secondary (background sources) were listed in detailed fashion.

Overhead Imagery

The EMSL-LV Advanced Monitoring Systems Division prepared an atlas of 25 photomosaics of selected parts of the study area in Jefferson and Orange Counties, Texas, and Calcasieu and Cameron Parishes, Louisiana. The mosaics were enlarged to a scale corresponding with the USGS topographic quadrangle sheets. Photo interpretation was derived from color infrared aerial photography flown at a scale of 1:65,000 during October 1978.

Specific categories of surface structures and facilities to be addressed in the study were specified by the ORD Office of Monitoring and Technical Support and Region 6. Photo analysis was accomplished utilizing Bausch and Lomb, Zoom 240, stereo-optics. This equipment provided an excellent stereo viewing capability up to 30 X. Identification of industrial sites by company name was aided by site location maps provided by NEIC and the 1978-79 Directory of Texas Manufacturers.

The Environmental Photographic Interpretation Center (EPIC) provided indexes to archival photography available for the study area. This photography had been collected during the following years: 1952, 1954, 1959, 1960, 1961, 1967, 1970, and 1971.

Process for Selection of Target Compounds

Because the cost of analyzing environmental samples increases with the number of compounds to be quantified, it was expected that it might be necessary to select a limited number of compounds for exposure assessment monitoring in subsequent phases of the program. The criteria developed to aid in the selection process were:

1. Information suggesting the presence in high concentrations in air or drinking water samples, and preferably in both.

2. Potential ability to collect and to analyze the compound using personal or portable monitors.

3. Established or suspected carcinogenic, mutagenic, or toxic properties.

4. Known high-quantity industrial production or use.

Five different sources of data on environmental concentrations, industrial production, and emission rates of toxic organic compounds were compared, and the compounds listed in Table 1 were found to be present in most or all of these tabulations. The tabulations used in this selection process included:

1. A study by Research Triangle Institute (RTI) under contract to the Office of Toxic Substances (OTS) to investigate halogenated hydrocarbons in five geographic areas--Houston, Texas; Baton Rouge, Louisiana; Buffalo-Niagara, New York; Newark, New Jersey; and Greensboro, North Carolina (Pellizzari, Erickson and Zweidinger 1979).

2. A study by Monsanto Research Corporation (MRC) under contract to the Environmental Sciences Research Laboratory (ESRL) to develop a personal sampler for atmospheric carcinogens (McMillan, Mote and DeAngelis 1980).

3. An epidemiologic study by the University of Texas School of Public Health (UTSPH) at Houston, under contract to the National Cancer Institute (NCI), in Jefferson, Orange and Brazoria Counties, Texas (Buffler 1980).

4. Preliminary air sampling results (vapor-phase organics) performed by RTI in February 1979 in Lake Charles, Louisiana.

5. Screening inspections of several facilities conducted by NEIC, including sampling of air, water and soil inside the plant fencelines.

Each of these studies eventually arrived at a list of compounds of potential significance to public health. The 29 compounds in Table 1 include all those that were observed in significant concentrations.

Drinking Water Supply Inventory

An inventory of community water supplies is maintained by EPA. Examination of this inventory showed that 157 community water supply systems serve 444,373 residents in the four-county/parish area of the study (Table 2).

TABLE 1. SUBSTANCES FOR STUDY IN THREE SIMILAR INVESTIGATIONS OR OCCURRING IN PRELIMINARY MONITORING

Compound	OTS/RTI (Houston/Baton Rouge) Air	OTS/RTI (Houston/Baton Rouge) Water	ESRL/MRC (Nationwide)	NCI/UTSPH (Jefferson-Orange)	Lake Charles Samples (RTI) Air	Lake Charles Samples (RTI) Water	Beaumont Samples (NEIC) Air	Beaumont Samples (NEIC) Surface Water	Beaumont Samples (NEIC) Soil
benzene			X	X	X		X		
carbon tetrachloride	X	X	X	X	X			X	
chlorobenzene	X								
chloroethane	X								
chloroform	X	X	X	X	X			X	
dichlorobenzenes	X	X		X				X	
tetrachloroethylene	X	X	X		X				
trichloroethylene	X	X	X	X	X				
1,1,1-trichloroethane	X	X			X			X	
1,1,2-trichloroethane					X				
1,1,2,2-tetrachloroethane					X				
1,1,1,2-tetrachloroethane					X				
vinyl chloride	X			X					
vinylidene chloride					X				
epichlorohydrin				X					
bis(chloroethyl)ether				X					
1,2-dichloroethylene					X				
mercury						X			
1,2-dichloroethane	X	X	X	X	X				
1,2-dibromoethane			X					X	
toxaphene									X
methylene chloride		X						X	
toluene							X	X	
chlorodibromomethane		X						X	
arsenic								X	
chromium								X	
copper								X	
cyanide								X	
dichlorobromomethane								X	

TABLE 2. SUMMARY OF COMMUNITY WATER SUPPLY SYSTEMS

Location	Number of Supplies	Population Served
Jefferson County, Texas	15	249,304
Orange County, Texas	72	61,653
Calcasieu Parish, Louisiana	67	128,966
Cameron Parish, Louisiana	3	4,450

In Jefferson County, the Beaumont water supply serves almost half of the county population (49 percent) from a mixed supply using both the Neches River and groundwater. Most other major community water supplies of the county use surface water sources.

The city of Lake Charles serves about 57 percent of the population of Calcasieu Parish with water from 12 wells. No community water supplies in the Louisiana portion of the study area depend on surface water sources.

Of the 157 systems, only 25 serve populations larger than 1,000. Due to limitations in analytical capability available for this study, eight of the larger supplies were selected for sampling. In order to provide representation of the entire study area, a ninth system in Cameron Parish was also selected.

Table 3 shows the community systems selected, the population served, source and treatment provided.

TABLE 3. SELECTED COMMUNITY WATER SUPPLIES

System	Population Served	Water Source	Treatment
City of Orange, Texas	26,100	Ground	Disinfection
Orange County, Texas WCID #3	6,760	Ground	Disinfection
City of Beaumont, Texas	120,000	Surface	Aeration, coagulation, chlorination sedimentation, filtration (rapid sand) pH adjustment
		Ground	Disinfection
City of Port Arthur, Texas	60,000	Surface	Prechlorination, coagulation, sedimentation, filtration, disinfection
Sulphur, Louisiana	17,047	Ground	Aeration, filtration, iron removal, disinfection
Lake Charles, Louisiana	83,000	Ground	Iron removal, filtration, chlorination
City of Groves, Texas	21,000	Surface	Aeration, prechlorination, coagulation. sedimentation, filtration, disinfection
Cameron, Louisiana	2,400	Ground	Disinfection

SECTION 5

METHODS

NEIC SOURCE DATA COMPILATION

Literature Search

A literature search was conducted in January and February 1979 using computerized information retrieval techniques. Data bases searched were selected from the more than 150 available to the NEIC technical information team based on their probability of containing environmental data on the study area. Data bases searched included APILIT, APTIC, Biological Abstracts, Chemical Abstracts, Cancerline, Compliance Data System (CDS), Compendex, EIS Industrial Plants, Enviroline, Medline, National Emissions Data System (NEDS), NTIS, Permit Compliance System (PCS), Pollution Abstracts, SCI SEARCH, STORET, Toxline and others.

The computerized search was conducted using primarily geographical search terms. Subjects were not limited. This resulted in identification of literature that used geographical terms associated with the study area as index terms. Some subject searching was also done. About 500 citations were identified in this manner. A review of the citations and associated abstracts identified about 150 of possible application to the study. Literature items present in the NEIC library were reviewed for appropriateness. Other items of interest were purchased or obtained through interlibrary loans. When received, these were also reviewed for appropriateness.

The results of this activity were a bibliography on more than 100 articles, reports, technical papers and directories with general or specific information on environmental conditions and sources of pollution in the study area. Many of the actual documents were also assembled. In addition, computer printouts totaling more than 4000 pages containing engineering and environmental data were obtained. This data compilation was made available to CERI for preparation of an annotated bibliography and to EMSL-LV for background purposes in several phases between February and May 1979.

File Search

A detailed review of appropriate EPA Region 6, state and local files was also initiated by NEIC in early 1979. EPA data reviewed included NPDES permit and compliance files, air program source files, hazardous waste disposal site files, wastewater treatment areawide planning documents, and source inspection reports. Data in the files of several EPA contractors were also reviewed. State and local agency files reviewed were at the Texas Air Control Board regional office in Beaumont, the Texas Department of Water Resources regional office in Orange and Southeast Texas Regional Planning Commission in Nederland.

Data extracted from these files consist primarily of location, product, process, air emission, wastewater discharge, pollution control, and hazardous waste disposal information on industrial facilities. At the end of 1979, most of the data in EPA files on the Texas portion of the study area had been extracted and about one-third of the Louisiana data. The file search is continuing.

Aerial Reconnaissance

An aerial reconnaissance of industrialized portions of the study area was conducted as a screening mechanism to assist in identifying actual or potential pollution problems not identified in file information and to define current onsite liquid and solid waste disposal practices.

Preparation for the aerial reconnaissance consisted of review of file information, conduct of a brief field reconnaissance and review of 1977 photographs for part of the area. File information was used to plot the location of known sources of pollution on topographic maps. These maps were then checked during a field reconnaissance in late February. Part of the area (limited by weather conditions) was observed from a light aircraft to define the extent of industrial sites and to spot unknown sources of pollution. A ground reconnaissance was then conducted to verify the names of as many industrial facilities as possible. The 1977 photographs provided additional site location data. Areas to be photographed were then selected from the compiled location data.

True color photographs (9-in. film transparencies) and thermal infrared imagery of all areas selected were recorded by EMSL-LV on April 21, 1979. The developed film was then transmitted to NEIC for photo interpretation.

A briefing package consisting of color slides of selected facilities and a detailed index was prepared and used to brief study participants and Region 6 personnel in May 1979. Color prints of selected facilities were also prepared for use in source evaluations. A detailed interpretation of the photographs is continuing as part of the source evaluation activities.

Completion of the background data compilations including file searches and photo interpretation was scheduled for mid-1980.

SAMPLING AND ANALYSIS OF AMBIENT AIR

Recent research supported by EPA has led to an air sampling method capable of detecting and quantifying gaseous volatile halocarbons in the parts per trillion (ppt) range. The method, described below, employs Tenax porous polymer to collect the vapors over a period of time (from 1 to 48 h) followed by thermal desorption and analysis by gas chromotography/mass spectrometry (GC/MS) techniques.

Vapor-Phase Organics

Collection--

Sampling and analysis were conducted by following the procedure developed by the Research Triangle Institute (RTI) under contract to EPA. The sampling method and materials are described in a series of reports by Pellizzari (1974, 1975, and 1979) and Pellizzari and Bunch (1979). The principle of the method is to concentrate the organic material onto a porous polymer collecting media (Tenax GC) which is packed in a cartridge, then forward the cartridge to an analytical laboratory for thermal desorption and analysis of the material sorbed on the Tenax media by use of gas chromatography/mass spectrometry/computer (GC/MS/COMP).

At the sampling site, the Tenax cartridge is installed in an instrument that has been designed to draw air through the cartridge at a controlled flow rate of 100 ml/min up to 2 l/min. At the beginning of each sampling period, the flow rate was measured with a calibrated rotameter attached to the inlet particulate filter. The sampling instrument is designed to maintain the flow rate and measure the volume of air moved through the cartridge. As the air moves through the cartridge, the volatile organic compounds are adsorbed onto the Tenax sorbent.

The organic vapors collected on the cartridges were used to characterize the organic materials. The cartridges were used for sampling periods of 1 to 2 h, or volumes of air of approximately 100 l.

Sample Processing--

The sampled Tenax cartridges received from the field were sealed in culture tubes using Teflon-lined screw caps, and in turn were sealed in aluminum "paint" cans. The cans were placed in a laboratory refrigerator that had not been used previously for storage of organic chemicals. (Blank Tenax cartridges left in the refrigerator for short periods of time did not show significant background contributions due to storage.) To prevent possible contamination, only the number of cartridges to be analyzed for 1 day were removed from the refrigerator. In the laboratory, sample cartridges remained sealed in the culture tubes and "paint" cans until analyzed. At this time, the Tenax cartridges were transferred to the instrument using stainless steel forceps.

Analysis--

At the laboratory the cartridge is placed in a preheated desorbtion chamber and helium purge gas flows through the cartridge to carry the vapors to a liquid nitrogen capillary trap. When the desorption of

the cartridge is completed, the capillary trap is heated and the trapped materials are transferred to a high resolution GC column by the carrier gas. The thermal desorption inlet-manifold used to accomplish the transfer of the vapors from the sampling cartridge to the GC column has been developed for this organic vapor sampling and analysis method.

The gas liquid chromatography resolves the vapors into individual peaks and a mass spectrometer continuously scans the material to provide a series of mass spectra. Information from the GC/MS is stored automatically in the computer memory and processed for subsequent identification and quantification of the compounds.

The procedure of collecting volatile organic substances on Tenax GC sorbent is presently the method of choice with full recognition of limitations of the procedure for monitoring the spectrum of atmospheric pollutants.

Many variables affect the range and sensitivity of the method, most important of which is the compound being identified. Table 4 gives the theoretical sensitivity of the GC/MS/COMP for certain atmospheric pollutants, as reported by Pellizzari and Bunch (1979). For example, Pellizzari and Bunch found the estimated detection limit for bromoform to be 0.03 ppt, whereas for methyl chloride, the estimated limit was found to be 1000 ppt. It should be noted that sensitivity and detection limit parameters must be developed by eacn laboratory and results may vary somewhat between laboratories. The Tenax method is not applicable to very volatile compounds, e.g., C_1 to C_5 alkanes, since highly volatile compounds are not adsorbed on the Tenax sorbent. The Tenax method can be applied for detection of nonpolar and relatively nonpolar compounds but is not suitable for identification of polar compounds or most inorganic gases.

Pellizzari (1979) has noted that the primary cause of interference in analysis is due to substances with isomeric forms that cannot be resolved by high resolution chromatographic column; the mass cracking patterns of each isomer are identical. The precision is stated to range from $\pm$10 to $\pm$30 percent for different substances.

Storage of the samples (exposed Tenax cartridges) for 4 weeks may be permissible, however degradation of the sample occurs to such an extent that results are unreliable if samples are stored for a longer time.

Quality Assurance--

A quality assurance protocol was established for the qualitative screening study of airborne organic compounds in the Beaumont-Lake Charles area.

TABLE 4. OVERALL THEORETICAL DETECTION LIMITS OF HIGH RESOLUTION GAS CHROMATOGRAPHY/MASS SPECTROMETRY/COMPUTER ANALYSIS FOR ATMOSPHERIC POLLUTANTS

Chemical Class	Compound	Estimated Detection Limit* ng/m^3	ppt
Halogenated hydrocarbon	vinyl bromide	250	57
	bromoform	0.340	0.03
	bromodichloromethane	1.300	0.22
	dibromochloromethane	0.667	0.07
	1-bromo-2-chloroethane	1.00	0.67
	allyl bromide	5.00	1.04
	1-bromopropane	5.200	1.06
	1-chloro-3-bromopropane	0.150	0.01
	1-chloro-2,3-dibromopropane	0.100	< 0.01
	1,1-dibromo-2-chloropropane	0.100	< 0.01
	1,2-dibromoethane	0.530	0.07
	1,3-dibromopropane	0.100	0.01
	epichlorohydrin (1-chloro-2,3-epoxypropane)	9.600	2.50
	epibromohydrin (1-bromo-2,3-epoxypropane)	0.300	0.05
	bromobenzene	0.100	0.02
	methyl bromide	500	135
	methyl chloride	2000	1000
	vinyl chloride	800	333
	methylene chloride	700	200
	chloroform	200	420
	carbon tetrachloride	250	400
	1,2-dichloroethane	32	8.15
	1,1,1-trichloroethane	66	12.45
	tetrachloroethylene	2.5	0.38
	trichloroethylene	10	1.92
	1-chloro-2-methylpropene	62	21.5
	3-chloro-2-methylpropene	62	21.5
	3-chloro-2-butene	83	28.8
	allyl chloride	83	28.8
	4-chloro-1-butene	38	13.2
	1-chloro-2-butene	13	4.5
	chlorobenzene	2.10	0.47
	o-dichlorobenzene	1.00	0.06
	m-dichlorobenzene	0.75	0.01
	benzylchloride	0.65	0.01

* Limits are calculated on the basis of the breakthrough volume for 2.2 g of Tenax GC (at 70°F), capillary column performance and sensitivity of the mass spectrometer to that compound in the mass fragmentography made of most intense ion.

Source: Pellizzari and Bunch (1979).

The basic points of the program involve:

- "Spiked" samples
- "Spiked" compound identification
- Blanks (field)
- Blind replicates
- Sample splits with other laboratories
- Stored samples for confirmation.

Sampling protocols were also specified for each aspect of the study: measurement of sampling times, flow measurements, sample handling, storage and documentation, and meteorological measurements.

RTI Pilot Project--

In addition to the establishment of specific protocols, a pilot study for the organic fenceline monitoring program in Lake Charles was conducted by the Research Triangle Institute (RTI), beginning in June 1978. This pilot project was intended to furnish the following type of information:

- Fenceline screening data at a production/use site of a large volume of organic compounds
- Data from which the field monitoring state-of-the-art technology can be assessed
- Information on the efficiency of the Quality Assurance Plan developed for the Beaumont-Lake Charles study.

The methods employed by RTI in this pilot study are detailed below.

Quality Assurance Aspects--Four types of samples were tested on Tenax GC cartridges: blanks, standard spikes, sampled spikes (controls) and field samples. Standard spikes and sampled spikes were loaded with organic compounds by RTI. Sampled spikes were loaded as a standard spike then transported to the field and sampled.

Standard spikes and blanks were divided into two groups: those sent to the field and returned without sampling and those kept in the laboratory under refrigeration. A comparison was made between the laboratory and field controls in order to discern whether any differences in the percent recovery occurred because of differences in cartridge handling. Table 5 summarizes the experimental parameters encompassing the Tenax GC cartridges used in the study, including parameters for

TABLE 5. SUMMARY OF EXPERIMENTAL PARAMETERS ENCOMPASSING TENAX GC CARTRIDGES FOR ORGANIC SCREENING STUDY

Experimental Parameter No.	Description
1. Blank Cartridges	Transported to the field, returned to the lab
2. Blank Cartridges	Stored in the lab freezer
3. Control Cartridges	Spiked with standards, transported to field, used in sampling, returned
4. Control Cartridges	Spiked with standards, transported to field, returned unused
5. Control Cartridges	Spiked with standards, stored in the lab
6. Spiked Cartridges	Freshly prepared day prior to analysis
7. Calibration Set	Spiked cartridges

Analytical Schedule

Day 1	Day 2	Day 3	Day 4
Instrumental set-up	Calibration, run controls	Calibration, run controls and samples	Calibration, run controls and samples

blanks and control cartridges. Table 6 lists a number of Tenax cartridges that were supplied for quality control purposes to the participating laboratories. Table 7 lists the organic compounds and their corresponding levels that were added to Tenax cartridges to serve as controls.

Ambient Air Sampling and Analysis--EPA provided personnel for sampling of ambient air in Lake Charles, Louisiana. Tenax GC cartridges were prepared by RTI and supplied to the EPA personnel. The ambient air stream was filtered with Teflon filters and pulled through a set of three Tenax cartridges in tandem. A total of eight sets of Tenax cartridges was housed in the sampling head. The sampler was operated for 24-h sampling periods, with a flow rate of 100 ml/min.

Upon completion of sampling, cartridges were shipped to RTI for analysis. Samples were analyzed at approximately 3-1/2 weeks after the preparation of Tenax GC cartridges.

The qualitative and quantitative analysis of the volatile organic vapors were performed essentially as previously described.

DRINKING WATER SAMPLING AND ANALYSIS

During July 1979, water samples were collected from nine selected drinking water supplies in the study area. These are the major water supplies in the area, and at least one supply was sampled from each county or parish in the study area.

Treatment is designed to clarify water and control microbiological contaminants. It is well known that conventional water treatment plants can accomplish these tasks, and these functions were not studied. The routine surveillance reports of the State health departments could be examined to verify expected results for these supplies, particularly for the surface water supplies. Groundwater supplies (wells) frequently are not treated, but in some cases disinfection is practical as a preventive, public health measure.

More recent research has indicated that water quality deteriorates during treatment and distribution. Trihalomethanes result from chlorination of water containing organics and metals, and asbestos fibers are picked up by the drinking water in the distribution system. Conventional treatment does little to remove synthetic organic chemical contaminants. The sampling and analysis protocols were designed to obtain data on these newer concerns.

The nine drinking water supplies were sampled before treatment and at a point in the distribution system. Those samples were analyzed for:

- Metals (Purdue University)
- Inorganics (Municipal Environmental Research Laboratory, EPA)

TABLE 6. SAMPLE DISTRIBUTION SCHEDULE FOR TENAX CARTRIDGES OF LAKE CHARLES, LOUISIANA (06/23/78-06/26/78)

Samples Collected 06/23/78-06/24/78

RTI[a]		ACB[b]		ORNL[c]		STORED[d]	
T-111	T-121	T-131	T-141	T-151	T-161	T-171	T-181
T-211	T-221	T-231	T-241	T-251	T-261	T-271	T-281
T-311	T-321	T-331	T-341	T-351	T-361	T-371	T-381

Samples Collected 06/24/78-06/25/78

RTI	ACB	ORNL	STORED
T-112	T-132	T-152	T-182
T-122	T-142	T-162	
T-172			

Samples Collected 06/25/78-06/26/78

RTI	ACB	ORNL	STORED
T-113	T-133	T-153	T-183
T-123	T-143	T-163	
	T-173		

[a]Research Triangle Institute, Research Triangle Park, North Carolina.

[b]Environmental Monitoring and Support Laboratory, Analytical Chemistry Branch, Research Triangle Park, North Carolina.

[c]Oak Ridge National Laboratory, Oak Ridge, Tennessee.

[d]Reserve cartridges held at EMSL/ACB, Research Triangle Park, North Carolina.

TABLE 7. ORGANIC COMPOUNDS AND THEIR LEVELS LOADED ON TENAX CONTROL CARTRIDGES

Compound	ng/cartridge
benzene	2,166
methyl vinyl ketone	4,200
d_6-benzene	1,629
n-heptane	1,961
tetrachloroethylene	1,626
benzonitrile	859
chlorobenzene	240
heptanal	749
bis-(2-chloroethyl) ether	91
methyl actylate	50
1,2-dibromopropane	1,151
ethylene dibromide	147
1,2-dichloroethane	1,745
perfluorobenzene	509
perfluorotoluene	606

- Asbestos (Health Effects Research Laboratory, EPA-Cincinnati)
- Organics (Energy Resources Company (ERCO)).

All 18 samples were analyzed and reported by all groups except ERCO, which did not report analyses for three samples due to contract problems.

For each of the nine systems, samples were collected at the plant (before chlorination), and at a random tap within the distribution system. Table 8 shows relevant water sampling location data. At each sampling point, 13 samples were collected:

- Five - 1 liter polyethylene cubitainers
- Six - 50 ml glass vials
- Two - 25 ml glass vials.

At the time of sample collection, field pH and dissolved oxygen (DO) were measured. The procedure for collecting and analyzing water samples is described in the remainder of this section.

Inorganic Sampling and Preservation

Before mailing to the field, the cubitainers were marked with a sample number and the type of preservative to be used in it. The number corresponded with the number on the EPA-9 form for that sample site. The type of preservative was marked on the container to avoid error or confusion for both the collector and the analyzer.

When ready to do the sampling at the site, the collector was instructed to open the cubitainer, rinse the container three times with sample solution, and to drain it out before finally taking the sample. An inch of head space was left in the cubitainer so that the preservative could be added and the insert put in place without spilling the solution.

Immediately after drawing the five cubitainers, two of the liter samples were treated with 1.5 ml of nitric acid each (for metals analysis), two with 1.5 ml of mercuric chloride (one for particulate, and one for nitrate and sulfate analyses), and one was left unpreserved. The preservatives were supplied by HERL-Ci so that blanks of the same lots of preservatives could be run for quality control purposes. Instructions on the use of the glass ampules of preservative were supplied.

After preservation, an insert was placed in the neck of the bottle. The insert served both to prevent leakage during shipment and to prevent contamination from the caps or cap liners. The insert was polyethylene and had been acid cleaned.

TABLE 8. DRINKING WATER SAMPLING LOCATIONS

Sample Number	Water Supply for	Type of Water	Source of Water	Sample Collection Point
23897	Orange, TX	Raw	Ground	Orange treatment plant well #1
23899		Finished		Tap*
23898	Orange County	Raw	Ground	Orange County WCID #3 treatment plant
23900	WCID #3	Finished		Tap
23911	Beaumont TX	Raw	Surface	Beaumont treatment plant
23901		Finished		Tap
23912	Beaumont, TX	Raw	Ground	Beaumont treatment plant
23902		Finished		Tap
23903	Port Arthur, TX	Raw	Surface	Port Arthur treatment plant
23904		Finished		Tap
23906	Sulphur, LA	Raw	Ground	Sulphur treatment plant
23905		Finished		Tap
23907	Lake Charles, LA	Raw	Ground	Lake Charles treatment plant
23908		Finished		Tap
23909	Groves, TX	Raw	Surface	Groves treatment plant
23910		Finished		Tap
23913	Cameron, TX	Raw	Ground	Cameron treatment plant
23914		Finished		Tap

* Samples of finished water were collected at randomly selected taps in the distribution system.

One of the nitric acid preserved samples was mailed for multielemental inorganic analysis to Purdue University. The other nitric acid preserved sample for metals, one mercuric chloride preserved sample for nitrate and sulfate analyses and the unpreserved sample were mailed to MERL-Ci, for drinking water standards analyses. The remaining mercuric chloride preserved sample was mailed to HERL-Ci, for asbestos fiber analysis.

Organic Sampling

Six large glass vials and two small glass vials sealed by teflon-lined septa and plastic caps were drawn at each collection site. The vials were muffled before shipment and had tags attached that contained the sample number on one side and the collection date on the other side. The vials were rinsed three times with sample solution and drained by the collector. The bottle was filled to overflowing. The cap was rinsed in a similar manner and filled with solution so that the closure would allow no air bubbles to remain in the vial.

Two of the large vials and two of the small vials were then sent for laboratory organic analysis. The remaining large vials were returned to MERL-Ci, for pH and alkalinity analyses.

Holding Times

Samples were drawn and mailed directly to the analyzers on the same day. Inhouse analyses by MERL were completed within 3 weeks of the sampling date, most of them within 10 days to 2 weeks.

It was requested that inorganic analyses performed at Purdue University be done preferentially to others upon receipt by the contractor. Half of these were completed 10 weeks after sampling. The remaining half were completed within 5 months.

Organic samples were sent to ERCO, Cambridge, Massachusetts. One-third of these analyses were done within 10 weeks and another half within 5 months. Three were not reported due to a contract problem.

Asbestos samples were analyzed inhouse, beginning upon receipt and ending 10 weeks later.

Analysis Methods

Alkalinity determination, as an alternative to field measurement, was done by titration to the carbonic acid equivalence point using a Metrohm E-636 Titroprocessor. pH was done by the method prescribed by Schock, Mueller and Buelow (1980). An independent check on one of the samples was done using the method for calcium and magnesium referenced in the USGS Open File Report 78-679 (1978).

Inhouse Analyses for Drinking Water Standards--

pH, Ba, Cd, Cr, Pb, Hg, Ag, Cl, Cu, Mn, Fe, Zn, Ca, Hardness, Alkalinity, Li, F, TDS, and SPC were done using Standard Methods for the Examination of Water and Wastewater (American Public Health Association 1976). NO_3 was done by the method prescribed by Kamphake, Hannah and Cohen 1967; Mg was done by the technique described in "Methods for Chemical Analysis of Water and Wastes" (U.S. EPA) (nitrous oxide flame); Si analysis was done according to methods described in "Standard Conditions for Silicon" (Perkin-Elmer); inorganic analysis at Purdue University was done by the methods discussed by Simms and Rickey (1978) and subsequently updated (1979); organic analyses at ERCO were done according to EMSL method 501.1; and asbestos analyses were done according to the method of Anderson and Long (1978).

SURFACE WATER, SEDIMENT AND FISH TISSUE ANALYSIS

All samples were collected and analyzed in accordance with "Interim Methods for the Sampling and Analysis of Priority Pollutants in Sediments and Fish Tissue" and "Interim Final Report--Sampling Protocols for Analysis of Toxic Pollutants in Ambient Water, Bed Sediment, and Fish," USEPA/OWWM/MDSD, February 1980.

FOOD ANALYSES

A Market Basket Survey was carried out by the Food and Drug Administration in Beaumont on February 18, 1980. Twelve composite food groups (dairy, meat, vegetables, fruit, etc.) were sampled for analyses of pesticides and metals. In addition, two fish samples were collected from the Calcasieu and Neches Rivers in August 1978, for similar analysis by EPA Region 6. Results of the Market Basket Survey will be published by the FDA in 1981.

SECTION 6

RESULTS AND DISCUSSION

From June 1978 to March 1980, a variety of activities were conducted in the Beaumont-Lake Charles study area. These activities, summarized in Table 9, centered around the testing and refinement of several monitoring and analytical methodologies. The collection of data for environmental or personal exposure assessment was secondary to the primary objective of this research effort; however, review and analysis of the sampling results may be useful in more closely defining future needs for monitoring and investigation in the Beaumont-Lake Charles area. This section will address both the methodological findings and the data generated as part of these efforts.

AMBIENT MEASUREMENTS

Air Sampling Results

Five trips were made to the study area in 1978-1979 for ambient air sampling:

- June 23-26, 1978--Lake Charles, Louisiana
- August 15-26, 1978--Beaumont, Texas-Lake Charles, Louisiana
- February 14-24, 1979--Lake Charles, Louisiana
- March 27-April 6, 1979--Beaumont-Port Arthur, Texas
- May 1979--Beaumont-Port Arthur, Texas.

The results of these site visits are described below.

Vapor-Phase Organics--

RTI Pilot Project--The first sampling visit to Lake Charles, Louisiana was made in June 1978 with the primary objective of adapting the thermal desorption technique developed by RTI to the needs of EMSL-RTP for future sample analyses in the Beaumont-Lake Charles study. The second objective of the June visit was to test several different sample collection techniques for organic vapors and particulate samples. In addition, several air samples were qualitatively analyzed by RTI, EMSL-RTP and Oak Ridge National Laboratory (ORNL) in an effort to test the agreement of chemical identifications between laboratories.

TABLE 9. OVERVIEW OF MONITORING METHODS DEVELOPMENT ACTIVITIES IN THE BEAUMONT-LAKE CHARLES AREA: 1978-1980

Date	Activity	Location	Purpose	Supporting/Performing Organizations
June 23-26, 1978	Sampling of organic gases	Lake Charles	Test Tenax, charcoal, evacuated cylinder, lab procedures	EMSL-RTP, RTI, ORNL
August 15-26, 1978	Sampling of organic gases Particulates sampling Ames test on particulate extract	Lake Charles	Test Tenax, charcoal Test HAS Test fractionation scheme, mutagenicity of fractions	EMSL-RTP, RTI EMSL-RTP, RTI HERL-RTP, RTI
Late August 1978	Aerial imagery-infrared	Lake Charles, Beaumont	Enforcement	Region 6, EMSL-LV
September 1978	Aerial imagery-true color	Lake Charles, Beaumont	Enforcement	NEIC
February 14-24, 1979	Sampling of organic gases and particulates Ames test on particulate extract Tradescantia	Lake Charles	Test Tenax, HAS and lab procedures Test fractionation scheme, chemical fraction mutagenicity Test mobile van Tradescantia concept, atmospheric mutagenicity	HERL-RTP, RTI HERL-RTP, RTI NIEHS, BNL, HERL-RTP
March 27-April 6, 1979	Sampling of organic gases and particulates Ames test on particulate extracts Tradescantia	Beaumont	Test lab agreement and HAS Test fractionation scheme Test mobile van Tradescantia concept, atmospheric mutagenicity	HERL-RTP, RTI NIEHS, BNL, HERL-RTP

(continued)

TABLE 9. (continued)

Date	Activity	Location	Purpose	Supporting/Performing Organizations
May 1979	Sampling of organic gases	Beaumont-Port Arthur	Test lab agreement	EMSL-RTP, OSHA
July 1979	Drinking water analysis	Beaumont-Lake Charles	Test for organics, asbestos, metals	HERL-Cl, MERL-Cl Region 6, Purdue, ERCO
May-November 1979	Tradescantia, Zea mays	Beaumont-Port Arthur	Test direct atmospheric effects on mutation frequency, biochemical measurements in plants	OHTS, University of Missouri
December 1979	Sampling blood from Lamar University students	Beaumont	Test analytical protocol for volatile organic compounds (VOCs) in blood	University of Miami
March 1980	Sampling of blood, personal air, breath, urine and drinking water from Lamar students	Beaumont	Test personal air quality monitors and breath measurement techniques for VOCs	RTI, University of Miami

The sampling protocol for the RTI studies in Lake Charles is given in Table 10. Sample site, code, sample time, volume and meteorological parameters are shown. All samples taken during this visit were collected in the parking lot of the Sheraton Hotel off U.S. Highway 90 at Lake Charles, and represent approximately a 24-h sampling period.

In the qualitative chemical analysis, RTI, ORNL and EMSL-RTP analyzed about 7000 spectra and identified 70-90 organic compounds in many samples. Tables A-1, A-2 and A-3 in Appendix A list organic compounds identified by the three laboratories in ambient air from Lake Charles during this visit.

The three laboratories involved employed somewhat different GC/MS methods. The following description refers to the EMSL-RTP method. Each sample chromatogram consisted of at least 3,000 computer scans with an average of 77 components identified. Samples T-141, T-241, and T-341 were thermally desorbed and collected in the cold trap. The combined desorbate was introduced to GC/MS as a single sample. Due to a computer malfunction, sample T-132 was lost after processing 2,000 scans. Therefore, what is presented for T-132 are identifications made from these 2,000 scans without a chromatogram or the identifications of the last 1,000 scans.

Each participating laboratory (EMSL-RTP, RTI, and ORNL) qualitatively analyzed about 10 samples. The sample distribution schedule is shown in the METHODS section, Table 6. Comparisons of qualitative identifications showed substantial agreement between laboratories.

At EMSL-RTP quantitation of vapor-phase organics was limited by the lack of standards for determining instrument response. Perchloroethylene was selected as a standard in the pilot study at Lake Charles as it appeared in most samples previously analyzed and permitted comparison with values obtained from other participating laboratories.

The quantitation was done by ratioing the concentrations of perchloroethylene to the area or intensity of the standards versus those of the samples. The areas and intensities were derived from the SIM (single ion monitoring) reconstructed chromatograms for the ions of m/e 164, 166, 168, and 133. The authenticity of ions was based on the relative abundances of 80, 100, 47, and 30 for the respective ions and the retention times. The average value for the retention times of standards and samples was 13.4 $\pm$ 0.2 minutes. The results of this method are in Table 11.

Table 12 presents a summary of analysis of the Tenax GC cartridge blanks and controls. Except for toluene, n-heptanal, n-nonanal, benzonitrile and acetophenone, the cartridges were essentially free of contamination. The results in Table 12 are for blanks that were either stored in the laboratory freezer throughout the period until analysis was initiated, or were cartridges that were transported to the field, returned and stored in the freezer at -20°C. The time that elapsed from their preparation until analysis was

TABLE 10. SAMPLING PROTOCOL FOR LAKE CHARLES, LOUISIANA (June 1978)[a]

Site	Sample Code	Sampling Time (min)	Sampling Volume (l)	Remarks	
Lake Charles, LA	T-111[b]	1430	151.6	6/23-24/78	36-31°C
	T-211[b]	1430	151.6	59-73% RH	
	T-311[b]	1430	151.6		
	T-121[c]	1430	143	6/23-24/78	36-31°C
	T-221[c]	1430	143	59-73% RH	
	T-321[c]	1430	143		
	T-112[c]	1425	132.5	6/24-25/78	35-36°C
				62-87% RH	
	T-122[c]	1425	146.8	6/24-25/78	35-36°C
	T-172[d]	1425	142	62-87% RH	
	T-113[c]	1476	144.6	6/25-26/78	32-36°C
				52-62% RH	
	T-123[c]	1476	150.6	6/25-26/78	32-36°C
				52-62% RH	

[a]Location was U.S. 90 at Sheraton Motel.
[b]Individually thermally desorbed, combined and analyzed as a singlet.
[c]Each cartridge individually analyzed by GC/MS/COMP.
[d]Cartridge spiked with standards was used in the first position of the sampling train

Source: Pellizzari 1979.

Sample Code:

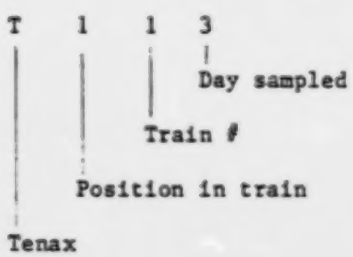


TABLE 11. ESTIMATED CONCENTRATIONS OF PERCHLOROETHYLENE IN AMBIENT AIR AT LAKE CHARLES, LOUISIANA

Sample Identification	ng/m^3 of Perchloroethylene[a] Intensity[b]	Area[b]
T-131	1938	1898
T-231	968	--
T-331[c]	--	--
Combined Desorb: T-141, T-241, T-341	202	191
T-142	948	882
T-133	6409	6315
T-143	7640	7616
T-173	9977	10547

a Corrected for breakthrough volume.
b Mean values based on SIM data for m/e 164, 166, 168 and 133.
c Trace amounts found but not accurately measurable.
See Table 6 for sampling protocol

TABLE 12. SUMMARY OF ANALYSIS OF TENAX GC CARTRIDGE BLANKS AND CONTROLS

Compound	Tenax Cartridge Number[a]					
	1	2	3	4	5	6
1,2-dichloroethane	-	T	-	-	-	565 ± 84
1,1,1-trichloroethane	-	-	-	-	-	-
1,1,2-trichloroethane	-	-	-	-	-	-
carbon tetrachloride	-	-	-	-	-	-
trichloroethylene	-	-	-	-	-	-
dibromochloromethane	-	-	-	-	-	-
chlorobenzene	-	-	-	-	-	175 ± 63
1,1,1,2-tetrachloroethane	-	-	-	-	-	-
bromoform	-	-	-	-	-	-
m-dichlorobenzene	-	-	-	-	-	-
o-dichlorobenzene	-	-	-	-	-	-
1,3-hexachlorobutadiene	-	-	-	-	-	-
1,2-dibromoethane	-	-	-	-	-	128 ± 13
1,2-dibromopropane	-	-	-	-	-	760 ± 19
toluene	T	T	77	77	T	-
ethylbenzene	-	-	T	T	-	-
naphthalene	-	-	-	-	-	-
-methylnaphthalene	-	-	-	-	-	-
n-hexanal	-	-	T	-	-	-
furfural	-	-	-	-	-	-
n-heptanal	T	T	-	-	T	-
n-nonanal	T	T	T	-	T	-
benzonitrile	T	-	-	-	-	550 ± 67
acetophenone	T	-	T	-	T	-
di-n-propyl ether	-	-	-	-	-	-

[a]Numbers 1, 2 = blanks stored in laboratory freezer, not transported
Numbers 3, 4, 5 = blanks transported to field and returned, stored in freezer.
Number 6 = average values for two cartridges spiked with standards, stored in freezer, not transported.

Values reported in ng/cartridge.

Source: Pellizzari 1979.

initiated was approximately 4 weeks. Two cartridges spiked with standards which were stored in the freezer and not transported were also analyzed and these results are also presented in Table 12.

Table 13 gives a summary of the recoveries for organic vapors on Tenax GC control cartridges. A comparison was made between the laboratory and field controls in order to discern whether any differences in the percent recovery occurred because of differences in cartridge handling. Few apparent differences were observed for these few selected compounds. Generally, it is desirable to analyze the sample within 3 weeks after their collection since the recoveries begin to diminish considerably beyond this time (Pellizzari 1975). This is exemplified by 1,2-dichloroethane, tetrachloroethylene and n-heptanal. The remaining compounds gave essentially quantitative recoveries at 4 weeks of storage. Bis-(2-chloroethyl)ether and methyl acrylate were not detected in the spiked controlled cartridges. This may be due to a moderate to low recovery coupled with the very low quantity which was loaded. The percent recoveries for standards loaded onto cartridges at levels below 100 ng has not been extensively studied by RTI. It is believed that the percent recovery of standards from sorbents will vary to some degree with the level that has been adsorbed to its surface.

As part of this study, a number of Tenax GC cartridges were sampled in tandem and then submitted to thermal desorption, vapors condensed and analyzed as a composite injection into the GC/MS/COMP system. In other cases, the individual cartridges in a sampling train were analyzed or replicate cartridges were submitted for analysis. Table 14 presents the estimated levels of 1,1,2,2-tetrachloroethene on Tenax GC cartridges which were used in Lake Charles, Louisiana. Given in Table 14 is the quantity of tetrachloroethylene which was observed per cartridge as well as per m^3 and ppt with the latter values corrected for recovery based on the controls (Tenax cartridges spiked with the standard). The results given here are consistent with the determined breakthrough volume for tetrachloroethylene in that the results indicate the breakthrough volume was exceeded during sampling (see Table 10). This is apparent for the results obtained for Tenax cartridges coded T121, T221, and T321 as compared to their corresponding composite. The cartridges T121 and T221 contained substantial quantities of tetrachloroethylene whereas only a trace was found on the third cartridge T321. Since the breakthrough volume at the ambient temperature during sampling in Lake Charles, Louisiana is approximately 106 l, the distribution of tetrachloroethylene between the first and second cartridge as observed in Table 14 is consistent with this determined breakthrough volume. This is an important facet for quantification of compounds in those cases where the breakthrough volume has been exceeded during sampling. It is still possible to calculate an estimated quantity of a particular compound if the breakthrough volume is taken into account since it is defined as that amount of air volume which is required to move a discrete sample through the cartridge with a subsequent 50 percent loss of the sample. Thus, one may calculate the concentration based on the latter portion of the sampling period. Also given in Table 14 are the replication results observed for Tenax cartridges (T113 and T123).

TABLE 13. SUMMARY OF RECOVERIES FOR ORGANIC VAPORS ON TENAX GC CONTROL CARTRIDGES

Standard Compounds	ng added	Laboratory Controls[a]		Field Controls[b]	
		ng observed	% recovery	ng observed	% recovery
methyl vinyl ketone	4,200	1,595 ± 59	38 ± 1	NQ[c]	-
1,2-dichloroethane	1,745	565 ± 84	33 ± 5	598 ± 95	34 ± 1
benzene	2,166	1,430 ± 8	67 ± 1	-	-
d_6-benzene	1,629	1,076 ± 6	66 ± 1	-	-
n-heptane	1,961	1,647 ± 71	84 ± 4	-	-
1,2-dibromomethane	147	128 ± 13	87 ± 9	145 ± 0	99 ± 0
tetrachloroethylene	1,626	580 ± 24	36 ± 1	617 ± 69	38 ± 4
chlorobenzene	240	175 + 63	73 ± 26	310 ± 38	129 ± 16
1,2-dibromopropane	1,151	760 + 19	66 ± 2	902 ± 7	78 ± 1
n-heptanal	749	167 ± 3	22 ± 1	NQ	-
benzonitrile	859	550 ± 67	64 ± 8	570	66
bis-(2-chloroethyl)ether	91	ND[d]	-	ND	-
methyl acrylate	50	ND	-	ND	-

[a]Tenax cartridges were spiked with standards as indicated, stored in laboratory freezer (-20°C), duplicate values.
[b]Tenax cartridges were spiked with standards as indicated, transported to field, returned, stored in freezer. Total storage time 4 weeks.
[c]NQ = not quantitated.
[d]ND = not detected, detection limit unknown.

Source: Pellizzari 1979.

TABLE 14. ESTIMATED LEVELS OF 1,1,2,2-TETRACHLOROETHENE ON TENAX GC CARTRIDGES USED IN LAKE CHARLES, LOUISIANA[a]

Coded Parameter	ng/cartridge[b]	ng/m^3[c]	ppt[d]
T111 + T211 + T311[e]	759 ± 5	5,270	2,692
T121	601 ± 9	5,670	1,568
T221	433 ± 15	3,028	1,136
T321	T	T	T
T112	398	3,015	1,132
T122[f]	-	-	-
T113	1,618 ± 20	11,159	4,195
T123	1,391 ± 44	9,727	3,658

[a]See Table 10 for volumes sampled.
[b]Average values were calculated using m/z 166 and m/z 168 ions for each analysis.
[c]Uncorrected for recovery (storage, etc.).
[d]Values are corrected for recovery based on Tenax cartridges spiked with standards.
[e]Cryogenic trap flow dropped to near zero during thermal desorption of third Tenax cartridge.
[f]Power failure, sample lost.

Source: Pellizzari 1979.

Table 15 presents the total mass of organic materials on each cartridge exposed at Lake Charles, Louisiana. Presented in this table are the composite results of three cartridges (T11 + T211 + T311) compared to individual amounts on three cartridges exposed at the same time (T121, T221, and T321). Since in many of the cases the breakthrough volume was exceeded by the sampling volume, substantial quantities of each of these compounds appeared in the second and third cartridge in the tandem arrangement. However, an estimation can be made of their concentration if the breakthrough volume is used in these calculations. Also of interest is that in some of the cases, the concentration of organic vapors appear to be higher in the second and/or third cartridge of the tri-tandem arrangement, which implies that the concentration of that particular organic vapor was not a continuous uniform concentration in air throughout the 24-h period but varied in some fashion. In Table 15 are also the results of replicate analyses for T113 and T123. These were samples obtained from the third sampling period.

The estimated levels of several organics in ambient air from Lake Charles, Louisiana are given in Table 16. These results are calculated on the basis of either the sampling volume or breakthrough volume whichever is the least. The concentrations of tetrachloroethylene were generally in the low $\mu g/m^3$ range. The highest concentrations were observed during the third sampling period when it reached 10,433 ng/m^3. The concentrations of 1,2-dichloroethane (69,055), 1,1,1-trichloroethane (35,222) and 1,1,2-trichloroethane (40,400) all exceeded the concentration of tetrachloroethylene on the third sampling period. In fact, substantial quantities of 1,1,1,2-tetrachloroethane and bromoform were also observed.

In these studies, the reproducibility of analysis of Tenax cartridges for replicate samples is approximately $\pm$ 10-40 percent. The variability in the accuracy and reproducibility may be attributed to several factors.

The data presented here are subject to two qualifying statements: (1) the calculations are based on a 1-point calibration curve and (2) the cartridges were held for a prolonged period between sampling and analysis, which has been shown to result in a loss in concentration. Samples held for prolonged periods showed increased background in thermal desorption GC/MS analysis as shown in Figure 2. This additional background provided some difficulties to the interpretation of the data. Further work is needed to refine methods for quantifying vapor-phase organics in ambient air. A more indepth discussion of the range, sensitivity, interferences, reproducibility, advantages and disadvantages of the Tenax method can be found in Pellizzari and Bunch (1979).

August, 1978 visit--The second field trip to Lake Charles was conducted on August 15-26, 1978. The five sampling locations are listed in Table 17 and are shown on Figure 3. This field study was designed to evaluate different methods for collecting fenceline data of organic compounds near production

TABLE 15. MEASURED AMOUNTS OF SEVERAL ORGANICS ON SAMPLING CARTRIDGES FROM LAKE CHARLES, LOUISIANA[a, b]

Compound	Coded Parameter					
	T111 + T211 + T311[c]	T121	T221	T321	T112	T113/T123[d]
tetrachloroethylene	759	601	433	T[e]	398	1,504 ± 113
1,2-dichloroethane	159	283	45	21	-	1,243 ± 125
1,1,1-trichloroethane	238	78	88	111	32	317 ± 22
1,1,2-trichloroethane	182	122	171	74	35	404 ± 172
carbon tetrachloride	104	68	43	63	30	132 ± 18
trichloroethylene	NQ	NQ	NQ	NQ	11	184 ± 86
dibromochloromethane	147	130	96	34	64	230 ± 74
chlorobenzene	17	29	-[d]	-	7	-
1,1,1,2-tetrachloroethane	T	36	9	-	4	46 ± 15
bromoform	309	729	265	-	68	637 ± 220
m-dichlorobenzene	16	27	14	7	6	15 ± 6
o-dichlorobenzene	T	T	-	-	-	-
1,3-hexachlorobutadiene	-	T	-	-	-	12 ± 0
1,2-dibromoethane	-	-	-	-	-	-
1,2-dibromopropane	-	-	-	-	-	23 ± 0
toluene	1,566	2,179	-	-	290	NQ
ethylbenzene	190	354	-	-	57	155 ± 42
naphthalene	80	NQ	NQ[d]	NQ	56	118 ± 46
α-methylnaphthalene	16	24	2	-	6	T
n-hexanal	125	88	104	53	40	105 ± 44
furfural	37	79	40	T	30	29 ± 5
n-heptanal	502	262	151	123	109	170 ± 53
n-nonanal	1,081	1,105	149	158	721	259 ± 41
benzonitrile	34	62	10	11	19	33 ± 14
acetophenone	386	NQ	NQ	NQ	133	271 ± 120
di-n-propyl ether	13	15	-	4	22	48 ± 11
1,1,2,2-tetrachloroethane	NQ	NQ	NQ	NQ	NQ	122

[a]Values are in ng/cartridge.
[b]See Table 10 for sampling protocol.
[c]Triplicate cartridges were thermally desorbed, then analyzed by gc/ms/comp.
[d]Average of duplicate analysis by gc/ms/comp.
[e]T = Trace, not detected; NQ = not quantitated.

Source: Pellizzari 1979.

TABLE 16. ESTIMATED LEVELS OF SEVERAL ORGANICS IN AMBIENT AIR FROM LAKE CHARLES, LOUISIANA[a,b]

Compound	Mean	Coded Parameter		
		T121	T112	T113/123[c]
tetrachloroethylene	7,873	5,670	3,750	14,200 ± 1,070
1,2-dichloroethane	28,267	15,700	-	69,100 ± 6,940
1,1,1-trichloroethane	15,810	8,670	3,560	35,200 ± 2,440
1,1,2-trichloroethane	18,700	12,200	3,500	40,400 ± 1,720
carbon tetrachloride	5,913	5,230	2,310	10,200 ± 1,380
trichloroethylene	3,481	NQ	393	6,570 ± 3,070
dibromochloromethane	983	909	481	1,560 ± 501
chlorobenzene	86	203	53	-
1,1,1,2-tetrachloroethane	270	340	37	433 ± 141
bromoform	3,307	5,100	511	4,310 ± 1,480
m-dichlorobenzene	112	189	45	102 ± 41
o-dichlorobenzene	-	T	-	-
1,3-hexachlorobutadiene	27	T	-	81 ± 0
1,2-dibromoethane	-	-	-	-
1,2-dibromopropane	52	-	-	156 ± 0
toluene	6,761	17,900	2,380	NQ
ethylbenzene	1,320	2,480	429	1,050 ± 284
naphthalene	610	NQ	421	799 ± 311
α/n-methylnaphthalene	106	168	45	T
n-nonanal	4,967	7,730	5,421	1,750 ± 278
benzonitrile	267	434	143	223 ± 95
acetophenone	1,418	NQ	1,000	1,835 ± 812
1,1,2,2-tetrachloroethane	1,110	NQ	NQ	1,110[d]

[a]Values are in ng/m^3 of air. When the breakthrough volume for a compound was exceeded by sampling volume, it was used for calculating concentration.
[b]See Table 10 for sampling protocol.
[c]Average of duplicate cartridges.
[d]Single value.

Source: modified from Pellizzari 1979.

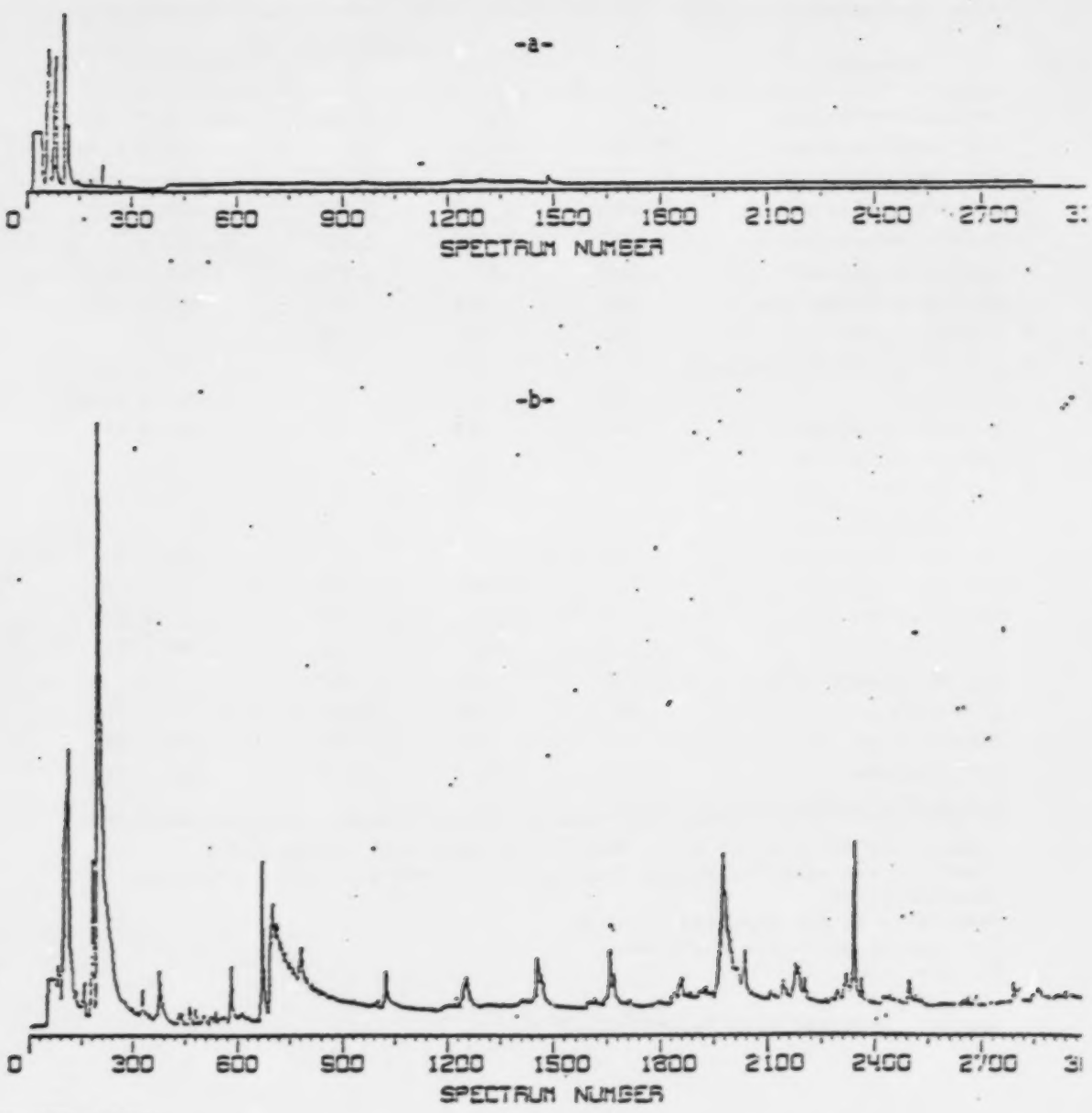


Figure 2. Comparison of two blank cartridges run by thermal desorption GC/MS techniques. The analyses were done (a) within 2 weeks after preparation and (b) after being held for 10 weeks with the Lake Charles samples.

TABLE 17. DESCRIPTIONS OF SAMPLING LOCATIONS AT LAKE CHARLES, LOUISIANA (AUGUST 15-26, 1978)

A.	Fourth pole from the end from John Stein Road on Walker Drive.
B.	Substation on Warren Street in Lake Charles (not used).
C.	Country Club in Lake Charles (not used).
D.	Highway 384 South, Pole #107.
E.	Third pole north of Highway 108 on Bodin Road.
F.	On Ohio Street between Georgia and Arkansas—middle pole.
G.	First Shell Road to Southwest of Chateau Charles on Highway 90 West-last pole on right.
H.	Sam Houston State Park near information center (not used).

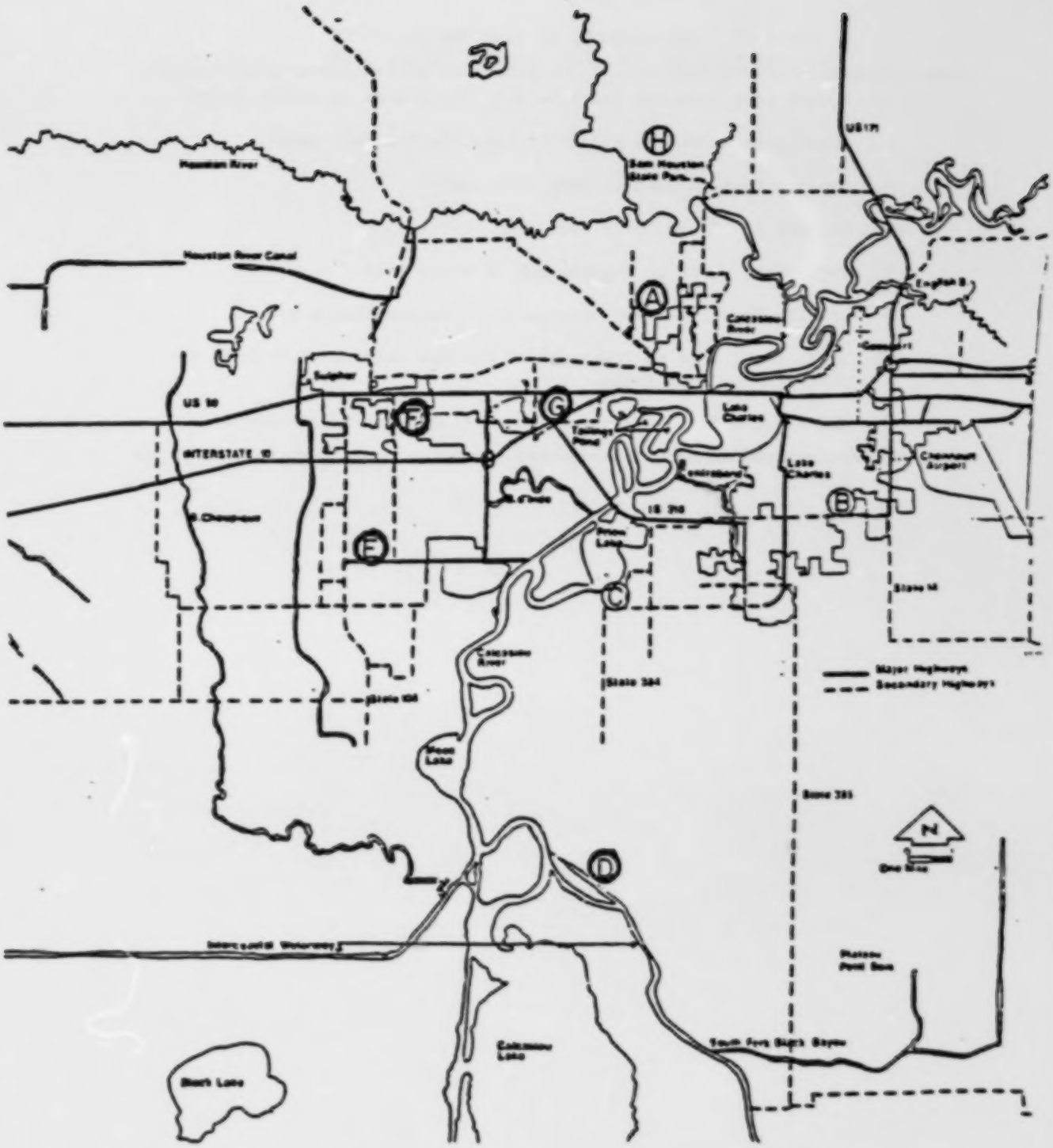


Figure 3. Possible organic screening sites in the Lake Charles area.

facilities. No Tenax cartridges were available, so charcoal cartridges were used for vapor organic sampling.

On this visit, no organic compounds were identified through the use of charcoal cartridges. Both of the first two Lake Charles visits found charcoal cartridges to be inadequate for collection of organic vapors present at low ambient concentrations. A variety of problems may be encountered with the use of charcoal cartridges for the determination of volatile organics in air. For vapors that can be trapped by the filter, there may be significant loss before analysis, reactions of organics with water on the filter leading to masking effects, and/or difficulties in desorption of the organics from the charcoal.

February 1979 visit--In February 1979, a third visit was made to Lake Charles. Sampling protocols are given in Tables 18 and 19. Four samples were collected over 2-h periods and four samples were collected over 2-d periods. The sites chosen for the Lake Charles visits are shown in Figure 4. Qualitative analyses revealed over 140 organic compounds in samples analyzed by RTI (Appendix A, Table A-4).

In 2-h samples (Table 20), three of the four samples contained quite low levels of organics with winds 10 to 20 kts from south to northeast. The fourth sample (P7/L3-T_1--a site with light and variable winds) showed 10 volatile organics with concentrations between 1 and 12 $\mu g/m^3$. Extremely high levels (up to 500 $\mu g/m^3$) of organic chemicals were found in four samples collected over 2-day periods during the same month (Table 21: note values are reported in $\mu g/m^3$). Since breakthrough volumes for nearly all compounds were considerably exceeded and since possibilities for displacement or other reactions were increased by the long sampling time, these values should be considered provisional. Additional sampling is needed to determine the cause of these high values in 48-h samples, as compared to the relatively low levels found in 2-h samples.

March-April 1979 visit--In March and April 1979, organic vapor samples were collected from Beaumont, Texas. The sampling protocols are shown in Tables 22 and 23 for the 2-h and 48-h sampling, respectively. Figures 5 through 9 show the sampling sites. The qualitative analyses revealed 137 organic compounds in these samples, 45 of which were present in all seven samples (Appendix A, Table A-5).

Results of the quantitative analyses for these vapor-phase organic samples from Beaumont are given in Table 24. These samples, collected over a 2-h period, contained organic vapor levels as high as 34 $\mu g/m^3$ (benzene, P4/L3). Of the four chemicals with the highest concentrations, benzene had the highest mean concentration.

May 1979 visit--An additional eight samples were collected in Beaumont in May 1979. (Sampling locations are listed in Table 25 and shown in Figure 10). Table 26 gives the sampling schedule for the May 1979 samples.

TABLE 18. SAMPLING PROTOCOL FOR VAPOR-PHASE ORGANICS IN LAKE CHARLES, LOUISIANA--2-h SAMPLES (February 1979)

Site	Sampling Period/Location	Sampling Time (min.)	Volume (liters)	Remarks	
Lake Charles, LA Off Highway 90 West & I-10	P1/L1	75	135.8	2/14/79 69°F	0835-0950 19°/10 kts
"	P2/L1	120	143.0	2/14/79 72°F	1230-1430 180°/20 kts
Lake Charles, LA Off I-210	P2/L2	120	166.1	2/14/79 72°F	1230-1430 180°/10-12 kts
Lake Charles, LA Off Highway 90 West & I-10	P3/L1	60	113.4	2/14/79 69°F	1639-1739 180°/15 kts
"	P4/L1	60	101.1	2/15/79 65°F	0904-1004 17°/12 kts
"	P5/L1	60	110.6	2/15/79 65°F	1653-1753 17°/12 kts
"	P6/L1	60	112.0	2/16/79 56°F	1419-1519 45°/5-10 kts
	P7/L1	120	126.0	2/16/79 53°F	1443-1643 45°/5-10 kts
Lake Charles, LA Off I-210	P7/L3	120	148.4	2/16/79 52°F	1445-1645 Var/Lt.
Lake Charles, LA Off Highway 90 West & I-10	P8/L1	60	101.0	2/19/79 34°F	0907-1007 270°/5-8 kts
"	P9/L1	60	103.0	2/19/79 36°F	1013-1113 270°/5 kts
"	P10/L1	60	104.0	2/19/79 36°F	1123-1223 270°/5 kts

TABLE 19. SAMPLING PROTOCOL FOR VAPOR-PHASE ORGANICS IN LAKE CHARLES, LOUISIANA--48-h SAMPLES (February 1979)

Site	Sampling Period/Location	Sampling Time (min.)	Volume (liters)	Remarks	
Off Highway 90W & I-10 (Sheraton Chateau Charles Lot)	P1/L1	2920	511	2/16-18/79 56°F	1020-1100 45°/5-10kts
Off Highway 90W & I-10 (Sheraton Chateau Charles Lot)	P2/L1	2864	501	2/18-20/79 34°F	1105-1049 90°/5-8 kts
Off Highway 90W & I-10 (Sheraton Chateau Charles Lot)	P3/L1	2789	488	2/20-22/79 53°F	1108-0937 180°/10-15 kts
Off Highway 90W & I-10 (Sheraton Chateau Charles Lot)	P4/L1	2870	502	2/22-24/79 55°F	0945-0935 175°/10-15 kts

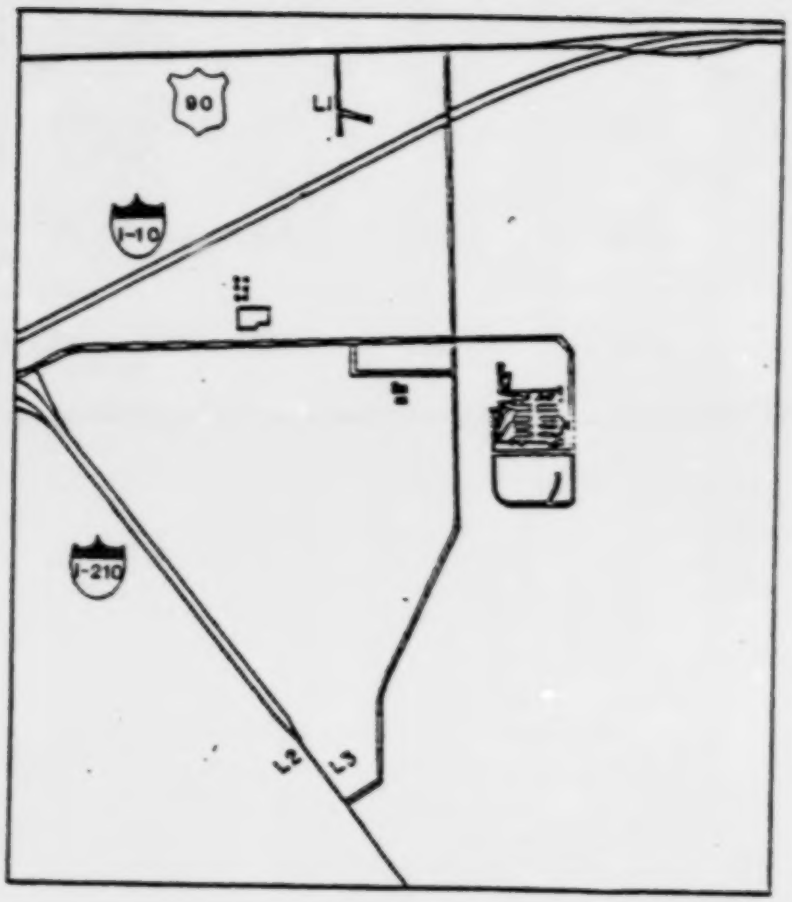


Figure 4. Sampling locations in Lake Charles, Louisiana.

TABLE 20. LEVELS OF SEVERAL VAPOR-PHASE ORGANICS IN LAKE CHARLES, LOUISIANA AIR (ng/m^3)--2-h SAMPLES (February 1979) **

Chemical	Period/Location			
	P2/L1-T1	P2/L2-T1*	P7/L1-T1*	P7/L3-T1
benzene	223	223	217	867
vinylidene chloride	51	ND	ND	6,226
chloroform	118	107	96	862
carbon tetrachloride	46	44	46	107
1,2-dichloroethane	66	47	1,309	11,516
1,1,1-trichloroethane	98	69	67	1,739
trichloroethylene	45	29	61	9,557
tetrachloroethylene	50	40	69	3,504
dichlorobenzene isomer	6	6	5	13
dichlorobenzene isomer	T	2	T	12
1,2-dichloroethylene	ND	ND	ND	8,233
1,2-dichloroethylene	ND	ND	ND	8,240
1,1,2-trichloroethane	ND	ND	53	3,632
1,1,1,2-tetrachloroethane	ND	ND	ND	741
chlorobenzene	ND	T	8	40
1,1,2,2-tetrachloroethane	ND	ND	64	4,946
1,3,5-trichlorobenzene	ND	ND	ND	8
pentachloroethane	ND	ND	ND	273
pentachlorobromoethane	ND	ND	ND	347
pentachlorobutadiene	ND	ND	ND	713
hexachlorobutadiene	ND	ND	ND	1,312
bromoform	ND	ND	ND	ND
bromocyclohexane isomer	ND	ND	ND	ND
chloromethylbutene isomer	ND	ND	ND	ND

* Upwind sample.
** See Table 18 for sampling protocol.

TABLE 21. VAPOR-PHASE ORGANICS IN AMBIENT AIR OF LAKE CHARLES, LOUISIANA ($\mu g/m^3$)--48-h SAMPLES (February 1979)*

Compound	Period/Location				
	P1/L1	P2/L1	P3/L1	P4/L1	B††
1,2-dichloroethane	51.9 ± 15	224 ± 24	293.9	40.3 ± 11	-
trichloroethylene	11.8 ± 0.1	0.5 ± 0.01	91.2 ± 1.1	11.5 ± 3.0	-
1,2-dichloroethylene	1.6 ± 0.2	1.1 ± 0.1	20 ± 1.0	T	-
vinylidene chloride	-††	22.4 ± 4.4	14 ± 2.0	23.1	-
1,1,2,2-tetrachloroethane	2.5 ± 0.5	1.8 ± 0.4	34.3	37.7 ± 20	-
1,1,2-trichloroethane	3.8 ± 0.1	32.9 ± 4.4	350 ± 0	32.1 ± 2.0	-
tetrachloroethylene	1.6	1.5 ± 0.3	45.3 ± 1.0	70.2 ± 28	-
1,1,1-trichloroethane	T**	33.5 ± 0.2	519 ± 21	178 ± 51	-
hexachlorobutadiene	32.3 ± 1.9	T	3.4	6.5 ± 1.0	-
benzene	6.8 ± 0.6	26.3 ± 3	2.8 ± 0.7	5.4 ± 0.8	T
chloroform	T	8.3 ± 1.0	10.0 ± 1.0	8.8 ± 1.7	T
1,1,1,2-tetrachloroethane	T	0.3 ± 0.05	12.5 ± 0.5	17.1 ± 2.1	-
pentachlorobutadiene	4.4	-	-	3.3 ± 1.8	-
pentachlorobromoethane	3.5	-	-	4.6	-
pentachloroethane	-	-	-	15.0 ± 2.0	-
carbon tetrachloride	12.2 ± 0.5	2.1 ± 0.02	20.5 ± 0.5	23.4 ± 4.4	T
chlorobenzene	0.3 ± 0.1	0.5 ± 0	1.9 ± 0	1.3 ± 0.3	-
dichlorobenzene isomer	0.17 ± 0.1	T	-	T	-
dichlorobenzene isomer	T	T	-	T	-

* See Table 19 for sampling protocol.
Values are in $\mu g/m^3$ for duplicate determinations.
** T = Trace.
†† = Not detected.
‡‡ = Blank cartridge.

TABLE 22. SAMPLING PROTOCOL FOR VAPOR-PHASE ORGANICS IN BEAUMONT, TEXAS AND VICINITY—2-h SAMPLES (March-April 1979)

Site	Sampling Period/Location	Sampling Time (min.)	Volume (l)	Remarks	
Beaumont, Texas Spur 136 Farm Rd.	P1/L1	2898	162.3	3/27-28/79 73°F	0955-1013 180°/10-15 kts
Beaumont, Texas West Port Arthur Rd.	P2/L1	120	99.7	3/27/79 77°F	1240-1440 180°/10-15 kts
Beaumont, Texas West Port Arthur Rd.	P2/L2	120	101.9	3/27/79 77°F	1240-1440 180°/10-15 kts
Beaumont, Texas West Port Arthur Rd.	P2/L3	120	88.6	3/27/79 77°F	1240-1440 180°/10-15 kts
Beaumont, Texas Farm Rd. 366	P3/L1	120	103.5	3/28/79 75°F	1210-1410 290°/15-20 kts
Beaumont, Texas Farm Rd. 366	P3/L2	120	113.6	3/28/79 75°F	1210-1410 290°/15-20 kts
Beaumont, Texas Farm Rd. 366	P3/L3	120	96.7	3/28/79 75°F	1210-1410 290°/15-20 kts
Beaumont, Texas Spur 136 Farm Rd.	P4/L1	120	111.6	3/30/79 72°F	1135-1335 290°/10-20 kts
Beaumont, Texas Spur 136 Farm Rd.	P4/L2	120	106.6	3/30/79 72°F	1135-1335 290°/10-20 kts
Beaumont, Texas Spur 136 Farm Rd.	P4/L3	120	114.7	3/30/79 72°F	1135-1335 290°/10-20 kts
Beaumont, Texas Spur 380	P5/L1		102	4/3/79 63°F	1125-1325 270°/10-15 kts
Beaumont, Texas Spur 380	P5/L2		98	4/3/79	1125-1325 270°/10-15 kts
Beaumont, Texas Spur 380	P5/L3		121	4/3/79	1125-1325 270°/10-15 kts
FM 347	P6/L1	60	86.9	4/5/79 62°F	0945-1045 90°/5-10 kts
FM 347	P6/L2	60	78.6	4/5/79 62°F	0945-1045 90°/5-10 kts
FM 347	P6/L3	60	80.3	4/5/79 62°F	0945-1045 90°/5-10 kts

TABLE 23. SAMPLING PROTOCOL FOR VAPOR-PHASE ORGANICS
BEAUMONT, TEXAS--48-h SAMPLES (March-April 1979)

Location	Sampling Period/Location	Sampling Time (min.)	Volume (l)	Remarks	
600 Pine Street	P1/L1	2898	162	3/27-29/79 73°F	0955-1013 180°/10-15 kts
600 Pine Street	P2/L1	2841	159	3/29-31/79 71°F	1035-0956 210°/15-20 kts
600 Pine Street	P3/L1	2895	162	3/21-4/2/79 76°F	1030-1045 210°/10 kts
600 Pine Street	P4/L1	1998	112	4/02-4/79 65°F	1100-1000 90°/10-20 kts
600 Pine Street	P5/L1	1655	93	4/04-6/79 65°F	1010-1345 45°/10-15 kts

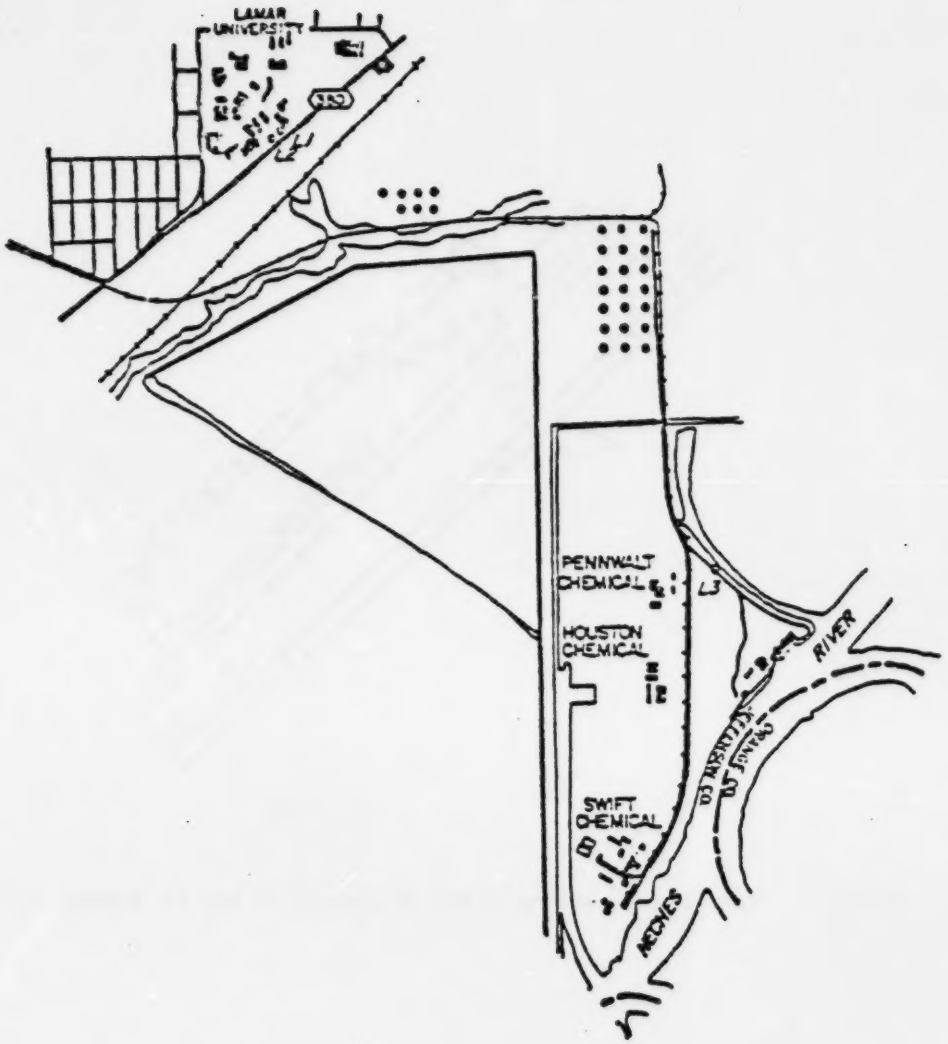


Figure 5. Sampling locations near Lamar University in Beaumont, Texas.

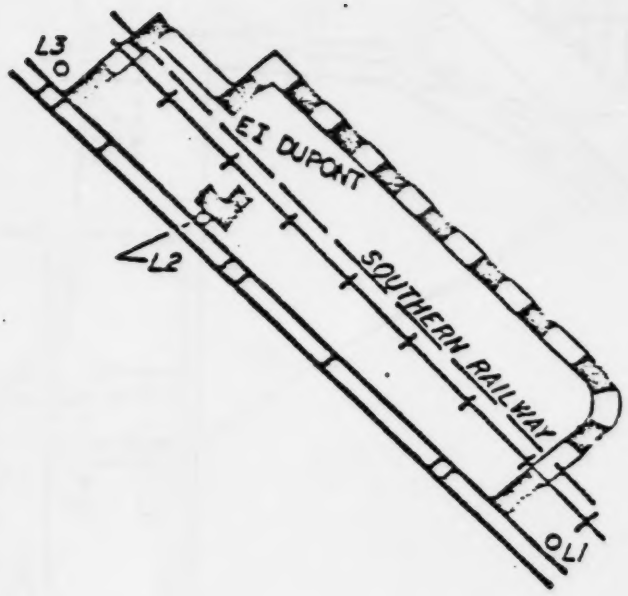


Figure 6. Sampling locations along Southern Railway in Beaumont, Texas.

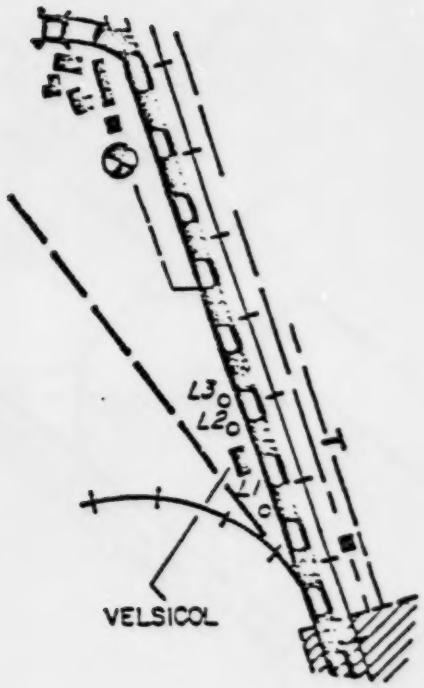


Figure 7. Sampling locations along West Port Arthur Road in Beaumont, Texas.

Figure 8. Sampling locations in Port Neches, Texas.

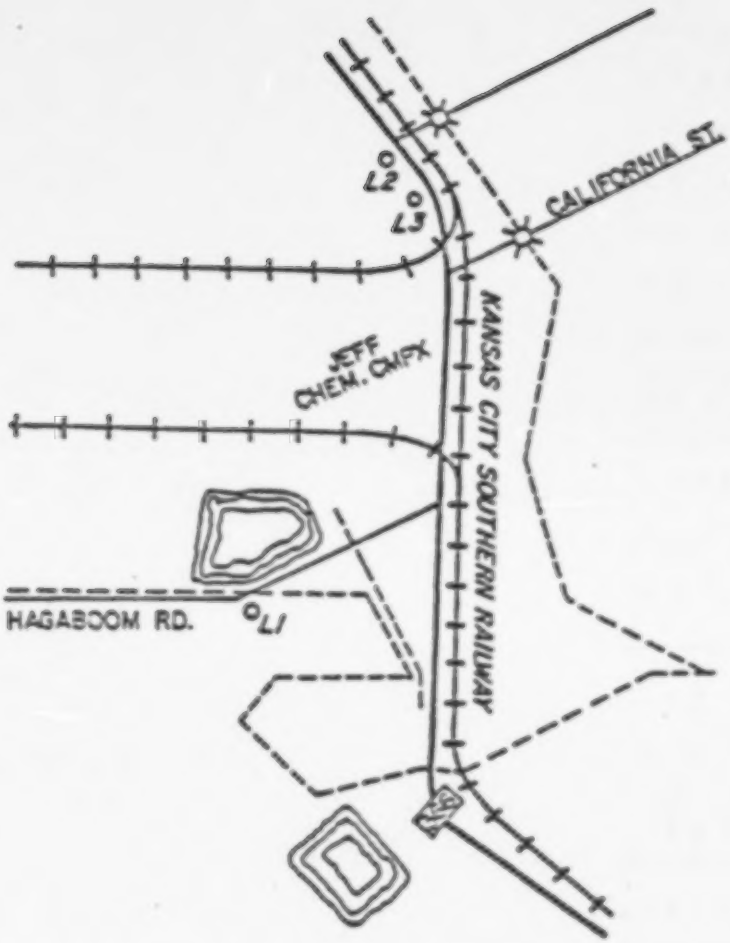


Figure 9. Sampling locations in Groves, Texas.

TABLE 24. LEVELS OF ORGANIC VAPOR-PHASE POLLUTANTS IN AMBIENT AIR OF BRAZORIA, TEXAS AND VICINITY (ng/m^3)--MARCH-APRIL 1979*

Compound	Period/location														
	P2/11	P2/12	P2/13	P3/11	P3/12	P3/13	P4/11	P4/12	P4/13	P5/11	P5/12	P5/13	P6/11	P6/12	P6/13
Ethyl acetate	133	208 ± 94	588	8,240	T	601 ± 252	3,809	383	4,140	9,533	6,140	T	861	1,960 ± 5	T
Benzene	4,220	5,110 ± 1,504	3,985	14,080	911	1,470 ± 306	7,743	1,063	33,848	8,346	6,326	3,240	4,411	2,478 ± 217	6,190
1,2-Dichloropropane	T	469	963	ND	2,547	1,410 ± 0	ND	T	ND	T	ND	T	ND	ND	T
Tetrachloroethylene	280	333 ± 139	648	628	294	780	864	629	930	2,920	4,80	436	334	303 ± 8	760
Chlorobenzene	80	119 ± 51	90	70	124	1,190	62	93	88	80	T	T	183	183	T
Carbon tetrachloride	516	666 ± 56	833	1,980	611	749 ± 194	964	772	681	14,389	712	1,280	770	1,629 ± 256	2,111
1,2-Dibromoethane	T	T	ND	ND	ND	T	T	ND	T	1,490	1,399	T	ND	ND	T

* See Table 23 for sampling protocol.

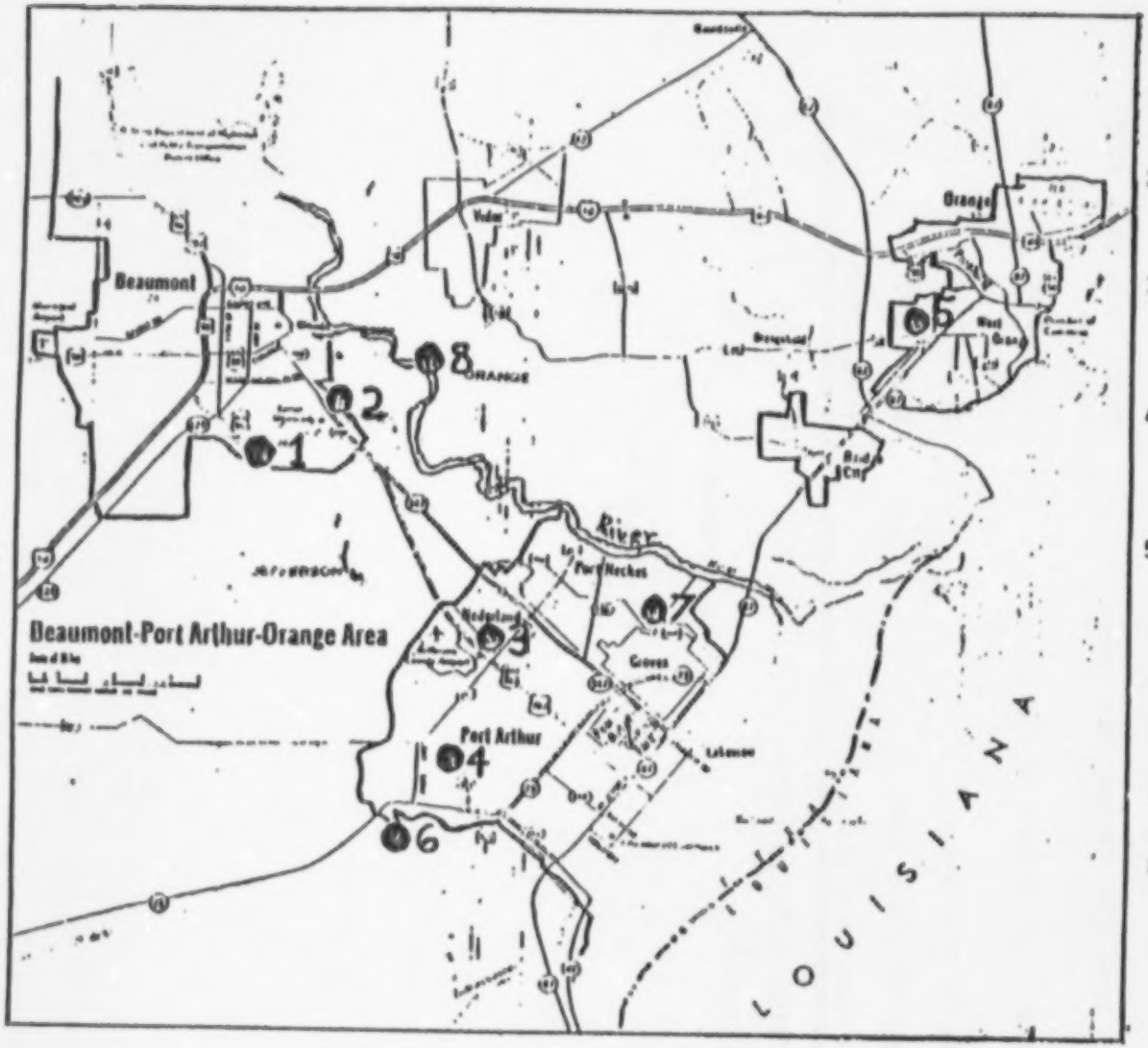
TABLE 25. SAMPLING LOCATIONS* IN THE BEAUMONT, TEXAS AREA--(May 1979)

Site	Sample Numbers
Gladys City Oil Company, Beaumont	T1113, 1313, 2113, 2213, 2313, 3113
Lamar University, Beaumont	T1123, 2123, 2223, 3223
Nederland Fire Station, Nederland	T1133, 1233, 2133, 2233, 2333, 3333
Port Acres Fire Station, Port Arthur	T1243, 1343, 2143, 2343, 3143, 4143
Orange County Airport, Orange	T1153, 2153, 2253, 3253, 3353, 4253
Site #6, Port Arthur	T1163, 2163
North of Groves, Texas	T1273, 2273
3-4 Miles SE of Beaumont	T1383, 2383

*Organic Screening Sample Code

Sample Code: Sample # T 1 3 4 3 (Example)

- 3 — City (3-Beaumont)
- 4 — Site #
- 3 — Day Sampled (1,2,3)
- 1 — Position in Sample Box
- T — Tenax-T, Charcoal-C



1. Beaumont - Located in Gladys City Oil Co. field southwest of industry
2. Beaumont - Located at Lamar University Stadium. South of industry. Residential.
3. Nederland - Located south and northwest of industry at fire station on Boston and Fourteenth St.
4. Port Acres - Located at fire station on Canal Street near 60th in residential area west and northwest of industries.
5. Orange - Located at Orange County Airport on Highway 87 west of residential and northwest of industry.
6. Port Arthur - Located at Mallard Hunting Club on Taylor Bayou just east of Highway 73.
7. Groves - Located north of Groves on Coke St. at the levee.
8. Orange - Located approximately 3 miles ESE of Beaumont in marshlands southwest of Vidor.

Figure 10: 1979 Beaumont Area Sampling Sites

TABLE 26. SAMPLING SCHEDULE
PORT ARTHUR/BEAUMONT/ORANGE--MAY 1979

Site # 1 - Beaumont - Gladys City Oil Co.

Day #	Tenax Cartridge Samples
1	4
2	2
3	2

2 Field Blanks
1 Sampled Spike

Site # 2 - Beaumont - Lamar University Stadium

Day #	Tenax Cartridge Samples
1	2
2	4
3	2

2 Field Blanks
1 Sampled Spike

Site # 3 - Nederland (Port Arthur) - Fire Station

Day #	Tenax Cartridge Samples
1	2
2	2
3	4

2 Field Blanks
1 Sampled Spike + 1 Unsampled Spike

Site # 4 - Port Acres (Port Arthur) - Fire Station

Day #	Tenax Cartridge Samples
1	4
2	2
3	2

2 Field Blanks
1 Sampled Spike

TABLE 26. (continued)

Site # 5 - Orange - Orange County Airport

Day #	Tenax Cartridge Samples
1	2
2	4
3	2

2 Field Blanks
1 Sampled Spike + 1 Unsampled Spike

Site # 6 - Port Arthur

Day #	Tenax Cartridge Samples
4	2

Site # 7 - Groves (Port Arthur)

Day #	Tenax Cartridge Samples
5	2

Site # 8 - Beaumont

Day #	Tenax Cartridge Samples
6	2

Summary for Port Arthur/Beaumont/Orange

46 Samples
10 Field Blanks
5 Sampled Spikes
2 Unsampled Spikes

63 TENAX CARTRIDGES TOTAL

Qualitative analyses of these samples by ORNL and EMSL-RTP revealed over 200 organic compounds in vapor-phase samples from Beaumont (Appendix A, Tables A-6 and A-7). Table 27 gives the estimated quantitative results of the May sample analyses. Of the eight chemicals quantified, benzene had the highest mean concentration (geometric mean = 6 $\mu g/m^3$) followed by 1,1,1-trichloroethane (geometric mean = 2 $\mu g/m^3$.

Overview--Table 28 summarizes the qualitative data for vapor-phase organics identified in samples from Beaumont-Lake Charles. This table gives only a rough indication of the frequency of occurrence of most chemicals, since limits of detection varied with sampling parameters, such as temperature and volume of air sampled. Thus, it cannot be used with certainty to identify chemicals that are present in one area and not in another. However, in conjunction with the quantitative results, it is possible to conclude that 1,1,2-trichloroethane was present in Lake Charles in greater abundance than in the Beaumont sampling sites. Several organics were consistently found in both areas: hexane, cyclohexane, benzene, methylcyclohexane, toluene, 2-methylpentane, 3-methylpentane and 2-methylhexane.

Figure 11 summarizes the observed levels of vapor-phase organics found during the sampling visits in Beaumont and Lake Charles. As clearly shown in the figure, the 48-h Lake Charles results were consistently the highest for the vapor-phase organics quantified, while the 2-h Lake Charles samples (collected during tne same February visit) showed some of the lowest concentrations.

Table 29 presents an overview of the number of vapor-phase samples for which quantitative analyses were conducted, and comparisons of the number of samples found at trace levels and those not detectable.

The ranges and frequencies of occurrence of the vapor-phase organics found in the study area are summarized in Table 30. The vapor-phase organics found most frequently in samples from the Beaumont-Lake Charles area include benzene, tetrachloroethylene, chlorobenzene, carbon tetrachloride, and 1,1,1-trichloroethane.

The highest maximum values were all observed in the Lake Charles 48-h samples. Since breakthrough volumes for nearly all chemicals were greatly exceeded in the 48-h samples, these values are subject to question. Table 31 presents the arithmetic means and maximum values for all vapor-phase organic determinations. The considerable variations observed indicate a need for comprehensive assessment of prevailing meterological conditions during the sampling periods.

Table 32 presents the relative standard deviations based on values obtained in duplicate analyses of a limited number of vapor-phase samples.

TABLE 27. ESTIMATED LEVELS OF SELECTED VAPOR-PHASE ORGANICS IN AMBIENT AIR FROM BEAUMONT, TEXAS AND VICINITY* (ng/m^3)--May 1979

Date in May	Sampling time (min.)	Sample Code	1,1,1-Trichloroethane	Benzene	Trichloroethylene	Toluene	Tetrachloroethylene	Chlorobenzene	Xylene	Ethylbenzene
4	1438.8	T1113	3,333	3,657	552	3,874	252	33	32	423
5	1442.2	T1123	4,444	6,613	1,034	16,514	688	50	10,459	1,651
5	1449.0	T1133	3,917	15,789	842	13,287	259	26	10,414	1,678
5	1439.3	T1153	3,000	3,125	342	4,104	209	24	1,433	239
8	1476.8	T2223	2,333	8,125	ND	5,955	154	18	6,273	909
8	1508.8	T1243	727	17,187	ND	8,636	164	18	5,636	2,409
9	119.0	T1163	1,692	4,622	744	3,913	139	43	2,606	591
6	120.0	T12/3	1,210	3,000	625	1,378	110	39	472	102
9	113	T1383	1,091	4,000	347	3,186	39	20	1,372	235
9	1429.5	S1333**	8,381	23,333	ND	32,157	506	500	26,765	3,598
		Blank Number 1	T	72	-	36	-	-	-	-
		Blank Number 2	T	142	-	100	-	-	-	-
		Blank TACB	T	-	-	-	T	T	-	-
		Geometric Mean	2,050	5,943	240	5,241	173	28	1,889	590
		Arithmetic Mean	2,416	7,347	498	6,750	223	30	4,307	915

* See Table 25 for sampling locations.
** Spiked

TABLE 28. FREQUENCY OF OCCURRENCE OF SELECTED ORGANIC COMPOUNDS QUALITATIVELY IDENTIFIED IN VAPOR-PHASE SAMPLES FROM BEAUMONT-LAKE CHARLES

Chemical	Frequency of detection		Percent Occurrence	
	Beaumont	Lake Charles	Beaumont	Lake Charles
cyclohexane	28/32	20/21	88	95
acetone	32/32	15/21	100	71
benzene	32/32	20/21	100	95
methylcyclohexane	32/32	19/21	100	91
toluene	32/32	20/21	100	95
2-methylpentane	31/32	19/21	97	91
hexane	31/32	17/21	97	81
benzaldehyde	31/32	7/21	97	33
3-methylpentane	30/32	17/21	94	81
3-methylhexane	30/32	16/21	94	76
heptane	30/32	14/21	94	67
methylcyclopentane	29/32	11/21	91	53
naphthalene	27/32	10/21	84	48
trichlorofluoromethane	26/32	5/21	81	24
acetophenone	26/32	8/21	81	38
2-methylhexane	25/32	18/21	81	86
octane	26/32	12/21	81	57
hexamethylcyclotrisiloxane	24/32	1/21	75	5
ethylbenzene	21/32	12/21	66	57
diethylphthalate	20/32	3/21	63	14
pentane	19/32	8/21	59	38
propylbenzene	16/32	3/21	50	14
perfluorotoluene	17/32	5/21	53	24
methylene chloride	17/32	12/21	53	57
xenon	17/32	4/21	53	19
phenol	18/32	2/21	56	10
3-methylheptane	19/32	6/21	59	29

(continued)

TABLE 28. (continued)

Chemical	Frequency of detection		Percent Occurrence	
	Beaumont	Lake Charles	Beaumont	Lake Charles
trichloroethylene	18/32	16/21	56	76
nonane	19/32	16/21	59	76
dodecane	19/32	15/21	59	71
1,1,2-trichloroethane	ND*	13/21	-	62
undecane	16/32	13/21	50	62
tetradecane	13/32	11/21	41	52
pentadecane	10/32	9/21	31	43
tridecane	16/32	11/21	50	52
xylene	11/32	10/21	34	48
1,2-dichloroethane	4/32	9/21	13	43
dimethylcyclopentane	10/32	7/21	31	33
fluorene	ND*	7/21	-	33
acetic acid	ND*	6/21	-	29
2-methylheptane	18/32	9/21	56	43
heptadecane	ND*	6/21	-	29
octadecane	ND*	6/21	-	29
2-butanone	6/32	6/21	19	29
nonadecane	ND*	5/21	-	24
decane	16/32	12/21	50	57
1,1,1-trichloroethane	17/32	11/21	53	52
∝-pinene	ND*	11/21	-	52
tetrachloroethylene	21/32	13/21	66	62
chlorobenzene	9/32	7/21	28	33
chloroform	10/32	11/21	31	52
carbon tetrachloride	13/32	4/21	41	19
o,m-dichlorobenzene	17/32	3/21	53	14
isopentane	14/32	11/21	44	52
ethyl acetate	6/32	9/21	19	43
methylnaphthalene	13/32	7/21	41	33
diethyl ether	ND*	7/21	-	33

* Not detected.

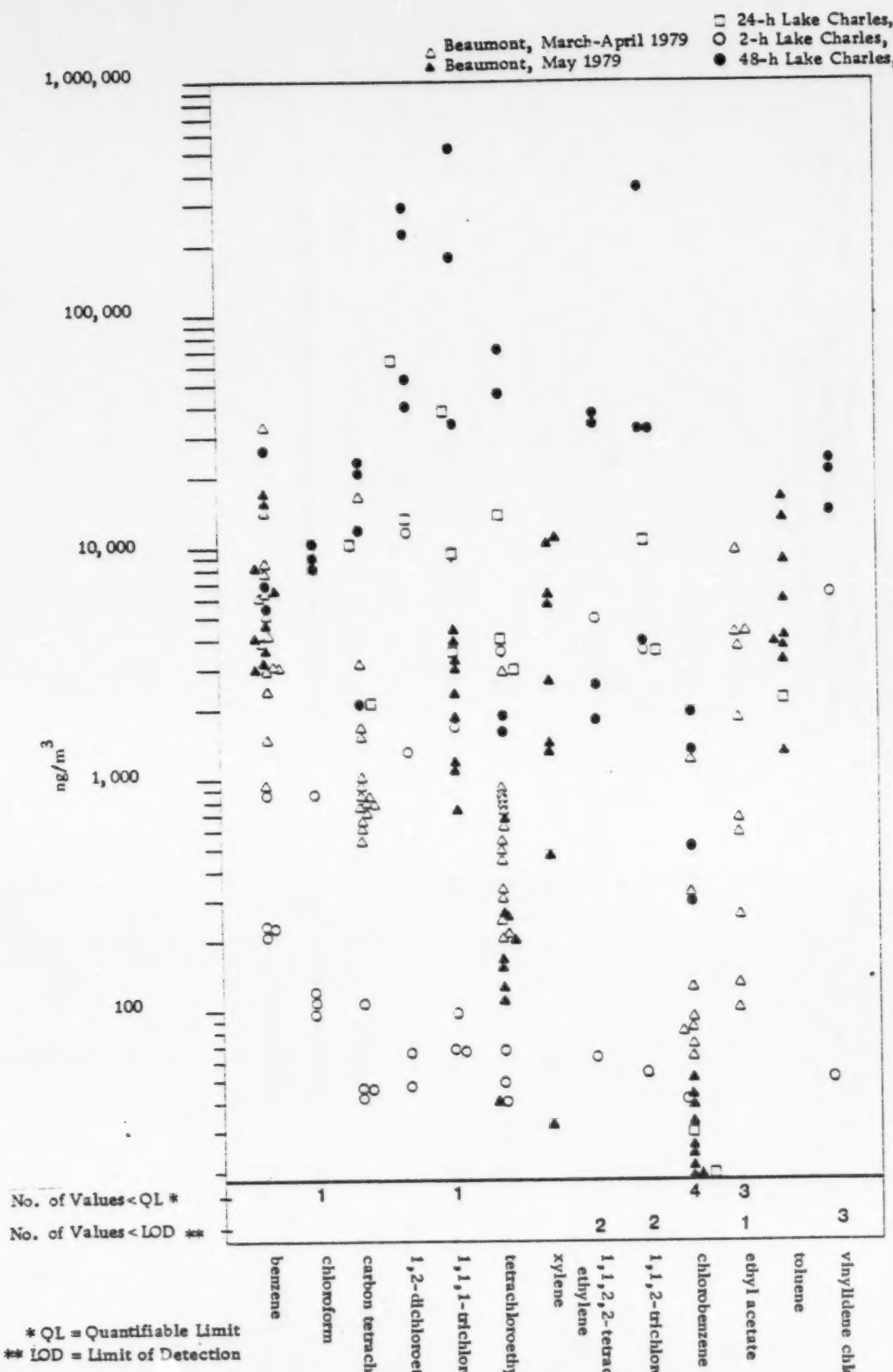


Figure 11. Observed levels of selected toxics in vapor-phase samples from Beaumont-Lake Charles

TABLE 29. OVERVIEW OF BEAUMONT-LAKE CHARLES VAPOR-PHASE ORGANIC ANALYSES FOR QUANTIFIED SAMPLES

	Lake Charles* (24-h Samples)	Lake Charles** (2-h Samples)	Lake Charles** (48-h Samples)	Beaumont (March-April 1979)	Beaumont (May 1979)
No. of samples	3	4	4	15	9
No. of chemicals quantified	23	24	19	7	8
No. of separate analyses	69	96	76	105	72
No. above trace levels	50	50	56	70	70
No. at trace levels	3	3	10	18	0
No. not detectable	16	43	10	17	2
Total organic concentration range (in $\mu g/m^3$)	14-175	0.6-55	133-1421	4-40	7-46

* June, 1978
** February, 1979

TABLE 30. LEVELS AND OCCURRENCE OF VAPOR-PHASE ORGANICS IN SAMPLES FROM BEAUMONT-LAKE CHARLES (ng/m^3)

Compound	Lake Charles									Beaumont		
	2-Hours			24-Hours			48-Hours			2-Hours		
	Concentration Range	Frequency of Detection	Percent Occurrence	Concentration Range	Frequency of Detection	Percent Occurrence	Concentration Range	Frequency of Detection	Percent Occurrence	Concentration Range	Frequency of Detection	Percent Occurrence
Benzene	220-870	4/4	100	-	-	-	2,800-26,000	4/4	100	900-34,000	24/24	100
Tetrachloroethylene	40-3500	4/4	100	3,800-14,000	3/3	100	1,600-70,000	4/4	100	39-3,000	24/24	100
Chlorobenzene	ND-40	3/4	75	ND-200	2/3	66	300-1,900	1/1	100	ND-1,200	22/24	100
Carbon tetrachloride	41-110	4/4	100	2,300-10,000	3/3	100	2,100-23,000	4/4	100	555-16,000	15/15	100
1,1,1-trichloroethane	67-1,700	4/4	100	3,600-15,000	3/3	100	T-520,000	4/4	100	727-4,400	9/9	100
Ethyl acetate	-	-	-	-	-	-	-	-	-	T-9,300	14/15	93
Trichloroethylene	29-9,600	4/4	100	ND-6,600	2/3	66	500-91,000	4/4	100	ND-1,000	7/9	78
Toluene	-	-	-	2,400-18,000	3/3	66	-	-	-	1,400-17,000	9/9	100
1,2-dibromomethane	-	-	-	-	-	-	-	-	-	ND-1,600	9/15	60
Chloroform	96-860	4/4	100	-	-	-	T-10,000	4/4	100	-	-	-
1,2-dichloroethane	47-12,000	4/4	100	ND-69,000	2/3	66	52,000-290,000	4/4	100	-	-	-
Dichlorobenzene isomer	T-11	8/8	100	ND-200	4/6	66	ND-170	6/8	75	-	-	-
1,2-dichloropropane	-	-	-	-	-	-	-	-	-	ND-2,400	7/15	47
1,1,2-trichloroethane	ND-3,600	2/4	50	3,500-40,000	3/3	100	3,800-150,000	4/4	100	-	-	-
1,1,2,2-tetrachloroethane	ND-5,000	2/4	50	NQ-1,100	3/3	100	1,800-38,000	4/4	100	-	-	-
Vinylidene chloride	ND-6,200	2/4	50	-	-	-	ND-23,000	3/4	75	-	-	-
1,2-dichloroethylene	ND-8,200	1/4	25	-	-	-	T-20,000	1/1	100	-	-	-
1,1,1,2-tetrachloroethane	ND-740	1/4	25	37-430	3/3	100	T-17,000	1/1	100	-	-	-
Hexachlorobutadiene	ND-1,900	1/4	25	ND-80	2/3	66	T-32,000	1/1	100	-	-	-
Pentachlorobromomethane	ND-350	1/4	25	-	-	-	ND-4,600	2/4	50	-	-	-
Pentachlorobutadiene	ND-760	1/4	25	-	-	-	ND-4,400	2/4	50	-	-	-
Pentachloroethane	ND-270	1/4	25	-	-	-	ND-15,000	1/4	25	-	-	-
1,3,5-trichlorobenzene	ND-8	1/4	25	-	-	-	-	-	-	-	-	-
Xylene	-	-	-	-	-	-	-	-	-	32-11,000	9/9	100
Ethylbenzene	-	-	-	57-350	3/3	100	-	-	-	100-3,600	9/9	100
Bromoform	ND	0/4	0	510-5,100	3/3	100	-	-	-	-	-	-
Dibromochloromethane	-	-	-	480-1,600	3/3	100	-	-	-	-	-	-
1,2-dibromopropane	-	-	-	ND-160	1/3	33	-	-	-	-	-	-
Naphthalene	-	-	-	NQ-890	3/4	100	-	-	-	-	-	-
α-methylnaphthalene	-	-	-	T-170	3/3	100	-	-	-	-	-	-
n-nonanal	-	-	-	1,800-7,700	3/3	100	-	-	-	-	-	-
benzonitrile	-	-	-	140-430	3/3	100	-	-	-	-	-	-
acetophenone	-	-	-	NQ-1,800	3/3	100	-	-	-	-	-	-

ND = not detected, NQ = present but not quantitated, - = not analyzed.

TABLE 31. ARITHMETIC MEANS AND MAXIMA OF VAPOR-PHASE ORGANICS IN LAKE CHARLES AND BEAUMONT AMBIENT AIR (μg/m³)

Compound	Arithmetic Mean					Maximum				
	Lake Charles Feb. 1979 2-h 4 samples	Lake Charles June 1978 24-h 3 samples	Lake Charles Feb. 1979 48-h 4 samples	Beaumont March/April 1979 15 Samples	Beaumont March/April 1979 9 Samples	Lake Charles Feb. 1979 2-h 4 samples	Lake Charles June 1978 24-h 3 samples	Lake Charles Feb. 1979 48-h 4 samples	Beaumont March/April 1979 15 Samples	Beaumont March/April 1979 9 Samples
1,2-dichloroethane	3.20	28.3	152.0	-	-	11.5	69.1	296.0	-	-
1,1,1-trichloroethane	0.49	15.8	181.0	-	2.42	1.74	35.2	519.0	-	5.4
1,1,2-trichloroethane	0.91	18.7	105.0	-	-	3.63	40.4	350.0	-	-
tetrachloroethylene	0.92	7.9	29.8	0.70	0.22	3.50	14.2	70.2	2.96	0.89
trichloroethylene	2.44	3.5	28.8	-	0.50	9.56	6.6	91.2	-	1.03
carbon tetrachloride	0.06	5.9	14.6	2.07	-	0.11	10.2	23.4	3.11	-
1,1,2,2-tetrachloroethane	1.25	1.1	19.1	-	-	4.95	1.1	37.7	-	-
vinylidene chloride	1.57	-	14.8	-	-	6.21	-	22.4	-	-
benzene	0.37	-	10.1	6.98	7.15	0.87	-	26.1	11.8	17.7
hexachlorobutadiene	0.31	0.03	10.6	-	-	1.31	0.08	32.1	-	-
1,1,1,2-tetrachloroethane	0.19	0.27	7.48	-	-	0.74	0.43	17.1	-	-
chloroform	0.30	-	6.78	-	-	0.86	-	10.0	-	-
1,2-dichloroethylene	2.06	-	5.68	-	-	8.21	-	20.0	-	-
chlorobenzene	0.01	0.09	1.09	0.14	0.03	0.06	0.20	1.90	1.19	0.05
dichlorobenzene isomer	0.01	0.05	0.02	-	-	0.01	0.19	0.17	-	-

TABLE 32. RELATIVE STANDARD DEVIATIONS OF DUPLICATE VAPOR-PHASE ANALYSES ON TENAX (%)

Chemical	Lake Charles					Beaumont			Mean
	T113/T123[1]	P1/L1[2]	P2/L2[2]	P3/L1[2]	P6/L1[2]	P2/L2[3]	P3/L3[3]	P6/L2[3]	
1,2-dichloroethane	10	29	11	-	-	-	-	-	10
trichloroethylene	47	0.8	2.0	1.2	25	-	-	-	15
1,2-dichloroethylene	-	13	9.1	5.0	-	-	-	-	9.0
vinylidene chloride	-	-	20	14	-	-	-	-	17
1,1,2,2-tetrachloroethane	-	20	22	-	53	-	-	-	32
1,1,2-trichloroethane	4	2.6	13	0	6.3	-	-	-	5.2
tetrachloroethylene	6.9	-	16	2.2	40	26	-	2.6	16
1,1,1-trichloroethane	6.9	-	0.5	4.1	29	-	-	-	10
hexachlorobutadiene	-	5.9	-	-	15	-	-	-	11
benzene	-	8.8	12	25	15	30	21	8.7	17
chloroform	-	-	12	10	19	-	-	-	14
1,1,1,2-tetrachloroethane	33	-	17	4	12	-	-	-	17
pentachlorobutadiene	-	-	-	-	55	-	-	-	-
pentachloroethane	-	-	-	-	13	-	-	-	-
carbon tetrachloride	14	4.2	0.1	2.4	19	8.3	26	15	13
chlorobenzene	-	33	0	0	23	17	-	-	15
dichlorobenzene isomer	40	59	-	-	-	-	-	-	50
ethyl acetate	-	-	-	-	-	35	37	0.3	24
1,2-dichloropropane	-	-	-	-	-	-	0	-	-
dibromochloromethane	32	-	-	-	-	-	-	-	-
bromoform	35	-	-	-	-	-	-	-	-
1,3-hexachlorobutadiene	0	-	-	-	-	-	-	-	-
1,2-dibromopropane	0	-	-	-	-	-	-	-	-
ethyl benzene	27	-	-	-	-	-	-	-	-
benzonitrile	42	-	-	-	-	-	-	-	-
n-nonanol	16	-	-	-	-	-	-	-	-
naphthalene	39	-	-	-	-	-	-	-	-
acetophenone	44	-	-	-	-	-	-	-	-

1 June 1979 samples
2 February 1979, 48-h samples
3 March-April 1979

The mean standard deviations ranged between 5 and 50 percent, depending on the chemical.

In this report, results will not be compared with findings from other parts of the country. Many variables may contribute to make such intercomparisons inaccurate or invalid, especially for quantitative data. Major factors to consider include:

- Variations in experimental conditions between studies, including treatment and handling of the samples, collection protocol and prevailing meteorological conditions.

- Sampling location--Many of the locations sampled in studies to date have been selected on the basis of proximity to industrial activity or potential for release of toxic substances including hazardous waste disposal sites. Such data will probably be overestimates of the levels of organics to which the general population would be exposed depending on the types of source and plume dispersion patterns. In addition, samples collected downwind of an industrial facility will usually be much higher than those collected upwind.

- The number of samples collected and the reproducibility of results within any given study.

Similar studies of organic vapors in ambient air have been conducted in other parts of the United States (Pellizzari, Erickson and Zweidinger 1979, Pellizari and Bunch 1979).

Benzene was detected in all samples collected from the Beaumont-Lake Charles area. Typical emission sources of benzene are chemical manufacturers, petroleum refineries, coke ovens, gasoline storage and handling, and internal combustion engines. According to Neufeld et al. (1978), the estimated normal ambient benzene concentration in urban air samples is reported to be 0.0 to 0.05 ppm (160 $\mu g/m^3$). The maximum level of benzene detected in the Beaumont-Lake Charles area was 34 $\mu g/m^3$, with geometric means of 1.5 $\mu g/m^3$ (Lake Charles) and 5.4 $\mu g/m^3$ (Beaumont).

Tetrachloroethylene was identified in many samples from Beaumont-Lake Charles. This compound is used as a solvent in drycleaning operations.

Vinylidene chloride was also identified in Beaumont-Lake Charles. Vinylidene chloride is an intermediate of the production of 1,1,1-trichloroethane. Sampling in Lake Charles in February 1979 revealed high ambient air concentrations of vinylidene chloride, and even higher levels of 1,1,1-trichloroethane as shown in Table 21 (vinylidene chloride maximum = 23,100 ng/m^3, and 1,1,1-trichloroethane maximum = 519,000 ng/m^3). Additional monitoring is necessary to determine the dispersion patterns for these chemicals and the levels in populated areas.

Drinking Water Analysis

The inventory of community water supplies for the Beaumont-Lake Charles area provided useful information on sources, treatment, and population served. Eighteen water samples from nine selected supplies were collected before and after treatment and analyzed for a variety of parameters (inorganics, organics, metals and asbestos) to characterize the quality of the drinking water in the area.

Field Measurements--

The results of pH and dissolved oxygen (DO) measurements taken in the field by the Surveillance and Analysis Laboratory (Houston) are given in Table 33. The alkalinity measurements were performed inhouse by MERL-Ci. It was found during analyses that many of the samples had precipitates, primarily iron. The samples could not be considered stable in all cases, and the pH values from those samples containing precipitates probably did not reflect the pH in their source environment. Iron precipitation has been observed to lead to a pH increase in some studies.

The small vials were found by MERL to provide an excellent means for isolating pH and alkalinity samples from atmospheric carbon dioxide effects. MERL recommends that the vials be filled without air bubbles, and should be rinsed with deionized water before shipment to ensure that there are no residual mineral salts. Refrigeration of samples collected for pH and alkalinity analysis should be avoided. Refrigeration may add to the possibility of introducing air from differential contraction of the sample and vial; in addition, the solubility of carbon dioxide in water increases substantially as the temperature decreases. The amount of change in pH and inorganic carbonate concentration depends on the initial pH and buffering capacity of the water sample and the difference between the equilibrium carbon dioxide partial pressure of the sample and the partial pressure of carbon dioxide in the atmosphere.

The alkalinity measurements conducted by MERL were done by titration to pH 4.5 by the Metrohm E-636 Titroprocessor. MERL found that the method of titration to the carbonic acid-bicarbonate ion equivalent point allows a much more accurate calculation of the total inorganic carbonate concentration, because the pH of that equivalence point changes with carbonate concentration. Total alkalinity titrations to a fixed-pH endpoint are inherently inaccurate for total carbonate concentration determination.

Inorganic Analyses--

Analyses of the water samples to determine compliance with Drinking Water Standards was conducted by MERL. One sample was mailed to Purdue University for multielemental inorganic analyses. The asbestos fiber analysis was conducted by the MERL-Ci.

TABLE 11. DATA FOR BEAUMONT, TEXAS-LAKE CHARLES, LOUISIANA--FIELD AND OTHER INORGANIC PARAMETERS

Sample EPA-68	SPC	Field DO[1] (mg/l)	Field pH	Inhouse Check pH[2]	DWS pH[2]	Inhouse Alkalinity[2] (mg/l)	DWS Alkalinity[1] (mg/l)	Hardness as $CaCO_3$ (mg/l)
23897	402	3.9	7.3	7.52	7.65	155 ± 2	151	50
23899	736	2.6	7.4	7.54	7.85	162.6 ± 1	133	46
23898	911	3.5	7.7	7.64	--	180	168	24
23900	1400	-	-	8.11	8.1	185.4 ± 2	176	28
23911	158	4.9	6.7	6.80	6.75	27.1	20	32
23901	269	6.1	8.5	8.89	8.45	51.0	53.0	64
23912	455	3.1	8.5	8.50	8.45	210	210	12
23902	476	6.2	8.4	8.71	8.5	216	208	16
23903	136	6.8	7.2	7.4	6.85	17.9 ± .06	-	32
23904	222	5.2	8.3	8.66	7.45	26.8 ± .1	25	44
23906	348	6.8	7.1	6.93	7.7	130	125	108
23905	362	3.0	7.0	6.82	7.5	141	133	118
23907	616	4.0	7.1	7.1	7.5	195	150	112
23908	677	3.5	7.5	7.67	7.8	156	156	112
23909	148	6.4	7.7	7.1	6.95	18.9	19	30
23910	276	6.6	7.8	8.30	7.75	23.0	24	32
23913	1700	3.2	7.6	7.61	7.9	314	321	140
23914	1780	2.2	7.8	7.73	7.95	331 ± 2	326	140
Ranges	126-1780	2.2-6.8	6.7-8.5	6.80-8.9	6.8 8.5	17.9-331	19-326	12-140

[1]Sample collected and stored in coolit/ainers for ~2 weeks.
[2]Sample collected and stored in glass for ~2 weeks (with no air space).

The levels of inorganics measured by MERL in the Beaumont-Lake Charles area were compared with National Interim Primary Drinking Water Standards (Table 34) and with Recommended National Secondary Drinking Water Standards (Table 35). The measured mercury levels in the distribution system for Sulphur, Louisiana and in both the plant and the distribution systems of Lake Charles and Cameron, Louisiana exceeded the National Interim Primary Drinking Water Standards. The samples were intended as a survey and, therefore, can only be interpreted as indicators of the need for further measurement. Additional compliance monitoring samples, as required by Federal Regulations, are needed to determine whether these values are representative. The collectors were instructed to take each plant sample before chlorination. The levels of mercury found in such samples may not represent the actual levels of mercury in drinking water initially entering the distribution system. It would be necessary to obtain corresponding samples of the finished water from each plant before conclusions could be drawn regarding these determinations.

A comparison of the Beaumont-Lake Charles inorganics data with the Recommended Secondary Drinking Water Standards revealed several parameters to be in excessive levels (Tables 35 and 36). The recommended chloride level was exceeded in both treatment plant and distribution system samples in Cameron, Louisiana. The plant sample was a prechlorination sample. Sodium levels were also highest in the Cameron groundwater samples indicating that the well may be affected by saltwater intrusion.

In the three cases where iron in the raw water is in excess of the recommended level, it is obviously reduced to acceptable levels by the time it reaches the sampling point in the distribution system. Only in Sulphur, Louisiana does the iron increase from below the recommended limit in the raw water to a very high level at the sampling point in the distribution system. This may be due to rust in the pipe system. Another possible explanation for the large variability would be the presence of colloidal iron, which would be very likely under most distribution system conditions.

As seen in Table 35, manganese levels in three plants drop to acceptable levels by the time they reach the sampling point in the distribution system. In Beaumont, Texas the drop in Mn still leaves a slightly higher than recommended level. This is based on only one analysis and it does not confirm systematic deviation from the recommended limit. However, Sulphur, Louisiana, and Lake Charles, Louisiana both have high levels of manganese in the raw water, and these levels remain relatively high in the distribution system.

Total dissolved solids appear to be significantly above acceptable standards in both raw water and distribution water for Orange, Texas, and high in Cameron, Louisiana, where no treatment is reported (Table 35).

It is interesting to note that each of these areas where inorganic levels exceeding standards were observed are served by groundwater sources. As groundwater migrates slowly (on the order of only tens or hundreds of feet per year) through soil and into an aquifer, the ionic content usually increases. As a result, most groundwater contains small to moderate amounts of sodium,

TABLE 34. INORGANIC CONCENTRATIONS OF DRINKING WATER FROM BEAUMONT, TEXAS-LAKE CHARLES, LOUISIANA COMPARED TO NATIONAL INTERIM PRIMARY DRINKING WATER STANDARDS (mg/l)

Sample EPA-9*	Water Supply	Location	Type	Ba	Cd	Cr	Pb	Hg	NO_3	Ag
23897	Orange, Texas	plant	ground	<0.2	<0.002	<0.005	<0.005	<0.0005	<0.2	<0.01
23897	Orange, Texas	tap		0.29	<0.002	<0.005	<0.005	<0.0005	<0.2	<0.01
23898	Orange County WCID #3, Texas	plant	ground	0.29	<0.002	<0.005	0.005	0.0005	<0.2	<0.01
23900	WCID #3, Texas	tap		<0.2	<0.002	<0.005	0.010	0.0005	<0.2	<0.01
23911	Beaumont, Texas	plant	surface	<0.2	<0.002	<0.005	<0.005	<0.0005	<0.2	<0.01
23911	Beaumont, Texas	tap		<0.2	<0.002	0.026	<0.005	<0.0005	<0.2	<0.01
23912	Beaumont, Texas	plant	ground	<0.2	<0.002	0.007	<0.005	<0.0005	<0.2	<0.01
23902	Beaumont, Texas	tap		<0.2	<0.002	0.040	<0.005	<0.0005	<0.2	<0.01
23903	Port Arthur, Texas	plant	surface	0.24	<0.002	<0.005	<0.005	<0.0005	<0.2	<0.01
23904	Port Arthur, Texas	tap		<0.2	<0.002	<0.005	<0.005	<0.0005	<0.2	<0.01
23906	Sulphur, Louisiana	plant	ground	0.25	<0.002	<0.005	<0.005	0.001	<0.2	<0.01
23905	Sulphur, Louisiana	tap		0.25	<0.002	<0.005	<0.005	0.0004*	<0.2	<0.01
23907	Lake Charles, Louisiana	plant	ground	0.26	<0.002	<0.005	<0.005	0.0010*	<0.2	<0.01
23908	Lake Charles, Louisiana	tap		0.21	<0.002	<0.005	<0.005	0.0*6*	<0.2	<0.01
23909	Groves, Texas	plant	surface	<0.2	<0.002	<0.005	<0.005	0.0013	<0.2	<0.01
23910	Groves, Texas	tap		<0.2	<0.002	<0.005	<0.005	0.0005	<0.2	<0.01
23913	Cameron, Louisiana	plant	ground	<0.2	<0.002	< 0.005	0.008	0.0004*	<0.2	<0.01
23914	Cameron, Louisiana	tap		0.21	0.004	<0.005	0.010	0.0004*	<0.2	<0.01
Interim standards (mg/l):				1.0	0.01	0.05	0.05	0.002	10.0	0.05
Range:				<0.2-0.25	<0.002-0.004	<0.005-0.040	<0.005-0.01	<0.0005-0.004	<0.2	<0.01
Number of positive determinations:				8	1	3	4	10	0	0

* Exceeds interim standards (subsequent samples analyzed by EPA Region 4 showed less than 0.002 mg/l).

TABLE 35. INORGANIC CONCENTRATIONS IN DRINKING WATER FROM BEAUMONT, TEXAS-LAKE CHARLES, LOUISIANA COMPARED TO RECOMMENDED NATIONAL SECONDARY DRINKING WATER STANDARDS (mg/l)

Sample EPA-9#	Water Supply	Location	Type	Cl	Cu	Fe	Mn	SO_4	TDS	Zn
23897	Orange, Texas	plant	ground	126	<0.02	0.22	0.03	<15	414	<0.02
23899	Orange, Texas	tap		186	<0.02	0.26	0.03	<15	448	<0.02
23898	Orange County WCID #3, Texas	plant	ground	180	<0.02	0.12	0.06[a]	<15	552[a]	<0.02
23900	Orange WCID #3, Texas	tap		201	<0.02	<0.1	<0.03	<15	579[a]	<0.02
23911	Beaumont, Texas	plant	surface	20	0.16	1.18[a]	0.11[a]	24	114	<0.02
23901	Beaumont, Texas	tap		26	0.05	<0.1	0.08[a]	32	166	<0.02
23912	Beaumont, Texas	plant	ground	17	<0.02	<0.1	<0.03	<15	282	<0.02
23902	Beaumont, Texas	tap		20	0.02	<0.1	<0.03	<15	284	<0.02
23903	Port Arthur, Texas	plant	surface	15	<0.02	1.38[a]	0.04	20	93	0.03
23904	Port Arthur, Texas	tap		30	0.02	<0.1	<0.03	22	135	<0.02
23906	Sulphur, Louisiana	plant	ground	26	0.15	0.24	0.42[a]	<15	242	0.06
23905	Sulphur, Louisiana	tap		26	<0.02	3.79[a]	0.46[a]	<15	253	<0.02
23907	Lake Charles, Louisiana	plant	ground	102	<0.02	1.98[a]	0.47[a]	<15	373	<0.02
23908	Lake Charles, Louisiana	tap		112	<0.02	0.35[a]	0.11[a]	<15	410	<0.02
23909	Groves, Texas	plant	surface	18	0.02	1.07[a]	0.15[a]	22	122	<0.02
23910	Groves, Texas	tap		26	<0.02	<0.1	0.04	56	176	<0.02
23913	Cameron, Louisiana	plant	ground	335[a]	<0.02	0.24	0.07[a]	<15	955[a]	0.10
23914	Cameron, Louisiana	tap		355[a]	<0.02	0.18	<0.03	<15	992[a]	<0.02
Recommended standards (mg/l):				250	1.0	0.3	0.05	250	500	5
Range:				15-355	<0.02-0.16	<0.1-3.79	<0.03-0.47	<15-56	93-992	<0.02-0.10
Number of positive determinations:				18	6	12	13	6	18	3

[a] Exceeds recommended standards.

TABLE 36. METALS IN DRINKING WATER FROM BEAUMONT, TEXAS-LAKE CHARLES, LOUISIANA

Sample EPA-#	Water Supply	Location	Type	Elements in mg/l									
				Ti	Sr	Ni	Ca	Mg	Si	Na	Li	F	K
23897	Orange, Texas	plant	ground	<.005	.25	.0001	13.5	2.27	24.0	156	.02	.5	1.80
23899		tap		.01	.23	<.0001	13.6	2.45	23.1	146	.02	.5	1.86
23898	Orange WCID #3	plant	ground	.006	.13	.001	4.0	1.59	16.2	202	.01	.4	1.2
23900		tap		<.003	.12	.001	6.5	.88	16.8	206	.01	.4	1.07
23911	Beaumont, Texas	plant	surface	.13	.11	.002	6.1	3.18	8.2	15.5	<.01	.1	2.76
23901		tap		<.003	.11	.002	17.9	2.77	4.1	29.8	<.01	.7	2.23
23912	Beaumont, Texas	plant	ground	<.003	.06	<.001	2.3	.54	6.9	103	<.01	.6	.562
23902		tap		.00[illegible]	.005	<.001	2.8	.45	4.8	105	<.01	.6	.607
23903	Port Arthur, Texas	plant	surface	.36	.08	.002	5.5	2.39	7.3	13.1	<.01	.1	2.09
23904		tap		<.004	.10	.002	9.8	2.03	5.3	29.8	<.01	.7	2.12
23906	Sulphur, Louisiana	plant	ground	<.005	.24	.004	22.5	8.38	27.9	34.	.01	.1	3.37
23905		tap		.009	.27	.001	24.9	8.99	28.1	37.8	.01	.1	2.56
23907	Lake Charles,	plant	ground	.011	.29	<.0001	26.0	9.28	23.0	82.0	.02	.2	2.20
23908	Louisiana	tap		<.006	.28	<.0001	25.8	8.65	24.7	97.0	.02	.2	2.40
23909	Grover, Texas	plant	surface	.202	.11		6.1	2.76	4.4	14.5	<.01	.1	2.56
23910		tap		.01	.10	.0005	6.3	2.84	7.2	39.5	<.01	.6	2.13
23913	Cameron, Louisiana	plant	ground	<.006	.40	<.0001	23.0	19.3	16.1	296	.02	.2	4.82
23914		tap		<.007	.39	<.0001	22.7	18.6	16.6	302	.02	.2	3.96

calcium, potassium, magnesium, bicarbonate, chloride and sulfate. The levels of the chloride, iron, manganese and total dissolved solids reported to be elevated in the above samples are not of public health significance. Iron tends to stain laundry and porcelain, and it can be tasted in concentrations higher than 0.5-1.0 mg/l. Water containing more than 0.5 mg/l of manganese may form objectionable deposits on cooked food, laundry, and plumbing fixtures. At high concentrations dissolved solids may impart taste to water. Chloride gives a salty taste to water, but may be physiologically safe in levels far exceeding the recommended level. Elevated sodium intake, however, has long been implicated in aggravated hypertensive and congestive heart disease.

It must be remembered that the secondary levels are recommended values and are not federally enforceable. Also, many of the parameters covered by the National Secondary Drinking Water Standards are subject to frequent variation and must be considered in that light. Table 37 summarizes the results of the inorganic analyses for drinking water samples.

Many of the samples were stored up to 5 months (inorganics and organics) before laboratory analyses were performed. Although preservatives were added at the time of collection, this does not prevent alterations in water quality over such long holding times. Allowable storage times depend upon several factors, including the character of the sample, the particular analyses to be made, and the conditions of storage. In general the shorter the time that elapses between collection of a sample and its analysis, the more reliable will be the analytical results.

Many ions normally found in water may not remain in the sample until analysis due to oxidation, reduction, precipitation, adsorption reactions and ion exchange. Coprecipitation may also reduce the concentrations of certain constituents in solution. Many water samples from Beaumont-Lake Charles contained precipitates, primarily iron, which coprecipitates other metal ions. The influence of such coprecipitation in reducing the levels of other metal ions in the samples from this study is unknown.

The asbestos fiber analyses were conducted by HERL-Ci. The data are shown in Table 38. Fibers increased in the distribution system in Beaumont, Texas where no asbestos-cement (A/C) pipe was reported in the system or in the plant. Two systems with A/C pipe in the distribution systems but not in the plant had increased fiber counts in the tapwater samples. All other systems had either no increase or a decrease in the distribution system fiber counts. In the two systems that reported A/C pipe in both the plant and the system (Sulphur and Cameron), the fiber counts decreased.

A level has not yet been set for fibers in drinking water, but concern for controlling asbestos in drinking water is growing (Millette et al. 1980). Based on calculations using the recommended occupational limit in air of 0.1 optically counted fibers per cubic centimeter of air, an equivalent value for a liter of water for all sizes of fibers would be from 4 to 15 x 10^6 fibers per liter (McCabe and Millette 1979). On this basis (concentrations above 15 x 10^6 fibers/liter), the data in Table 38 show only two values which indicate

TABLE 37. SUMMARY OF DRINKING WATER RESULTS--METALS AND INORGANICS

Compound	Number of Detectable Concentrations (18 max.)	Range (mg/l)	National Interim Primary or Recommended Secondary Standard (mg/l)	Number of Samples Above Standards
Barium	8	ND**-0.35	1.0	0
Cadmium	1	ND-0.004	0.01	0
Chromium	3	ND-0.04	0 05	0
Lead	4	ND-0.01	0.05	0
Mercury	10	ND-0.006	0.002	5*
Nitrate	0	ND	10.0	0
Silver	0	ND	0.05	0
Chloride	18	15-355	250	2
Copper	6	ND-0.16	1.0	0
Iron	12	ND-3.8	0.3	6
Manganese	13	ND-0.47	0.05	9
Sulfate	6	ND-56	250	0
Total Dissolved Solids	18	93-992	500	4
Zinc	3	ND-0.10	5.0	0

* All five samples in Louisiana. Subsequent sampling by EPA Region 6 showed values < C.002 mg/1.

** ND = Not detected.

TABLE 38. ASBESTOS FIBER COUNTS IN DRINKING WATER FROM BEAUMONT, TEXAS-LAKE CHARLES, LOUISIANA

Sample EPA-9#	Water Supply	Location	Type	Asbestos Pipes	Fiber Counts (10^6/1)	A.I**	Increase A.I.	Increase Fiber Counts (10^6)
23897	Orange, Texas	plant	ground	no	BDL (0.1)	11.01	+0.04	0
23899	Orange, Texas	tap		yes	NSS (0.1)	11.05		
23898	Orange County WCID #3 Texas	plant	ground	no	1.0	10.92	+0.64	1.3
23900	Orange WCID #3 Texas	tap		yes	2.3	11.56		
23911	Beaumont, Texas	plant	surface	no	BDL (1.0)	9.18	+2.69	3.8
23901	Beaumont, Texas	tap		no	4.8	11.87		
23912	Beaumont, Texas	plant	ground	no	8.4	11.58	-0.02	18.4
23902	Beaumont, Texas	tap		yes	26.8	11.56		
23903	Port Arthur, Texas	plant	surface	no	BDL (0.5)	9.57	+1.52	-0.4
23904	Port Arthur, Texas	tap		yes	NSS (0.1)	11.09		
23906	Sulphur, Louisiana	plant	ground	yes	1.5	10.95	-0.05	-0.5
23905	Sulphur, Louisiana	tap		yes	NSS (1.0)	10.9		
23907	Lake Charles, Louisiana	plant	ground	no	5.8	11.1	+0.40	-2.0
23908	Lake Charles, Louisiana	tap		yes	3.8	11.50		
23909	Groves, Texas	plant	surface	no	52.8*	10.16	+0.22	-48.3
23910	Groves, Texas	tap		yes	4.5	10.38		
23913	Cameron, Louisiana	plant	ground	yes	5.3	11.87	+0.20	-5.0
23914	Cameron, Louisiana	tap		yes	BDL (0.3)	12.08		

BDL = Below detection limit
NSS = Not statistically significant
* Sample was extremely turbid, diffult to quantify
** Aggressiveness index.

possible problems. One of these values (Groves, Texas) is from a very turbid sample that was difficult to quantify. The other value (Beaumont, Texas) is from a system that reportedly has A/C pipe. There could be other reasons than pipe corrosion for the elevated fiber count, such as recent work on the pipe system. In general , the data on fibers show only sketchy trends. There is evidence that other factors, such as levels of Zn, Fe, Mn, Si and saturation indices of several solids may be as good or better indicators of pipe condition and predictors of fiber release than the aggressiveness index (Schock, Logsdon and Clark 1980).

From the available data, the use of AI as currently employed with respect to asbestos-cement pipe, does not yield the expected answer (Schock and Buelow 1980). Furthermore, if future fiber counts were accompanied by a comprehensive water analysis as was done in this study, the question of indicators of fiber counts can be more reliably addressed. Further research is needed to determine (1) possible relationships between the presence of asbestos fibers and the use of asbestos/cement pipe in distribution and plumbing systems; and (2) the long-term human health effects of ingestion of asbestos in drinking water. With regard to the Beaumont site in particular, additional sampling is needed to determine whether the observed asbestos levels are representative, as well as the point of entry of the fibers into the water supply. Also, future fiber counts should be accompanied by a comprehensive water analysis to identify parameters which may be potential indicators of asbestos levels.

Organic Measurements--

Organic samples were analyzed by ERCO, Cambridge, Massachusetts, according to EMSL methods. Results are shown in Table 39. Elevated trihalomethanes (THM) were found in all three surface water systems sampled at the tap. THMs are synthetic organic substances created by oxidation of naturally occurring organic material. Chlorination of drinking water results in oxidizing conditions which are known to promote THM formation. Several THMs are carcinogenic in animals and may be toxic at extremely low concentrations. Elevated levels of THMs may be expected to follow chlorination. Chloroform (compound #1) increased to 170 µg/l in the chlorinated waters from the surface water source in Port Arthur, Texas. Chloroform was also found in high levels (190 µg/l) in another surface water sample from Beaumont, Texas. The corresponding plant sample showed no detectable chloroform. Finally, two duplicate samples from the remaining surface water system in Groves, Texas, showed an average chloroform value of 572 µg/l. These samples from Beaumont, Port Arthur, and Groves showed total trihalomethane levels of 239 µg/l (0.239 mg/l), 199 µg/l (0.199 mg/l) and 646, µg/l (0.646 mg/l), respectively. All three values exceed the National Interim Primary Drinking Water Regulation limit of 0.10 mg/l.

Levels of three other compounds (bromodichloromethane, dibromochloromethane, and bromoform) also increased following treatment, though to a lesser extent than chloroform. Bromoform levels increased in chlorinated

TABLE 39. DATA FOR BEAUMONT, TEXAS-LAKE CHARLES, LOUISIANA--
ORGANIC ANALYSIS REPORTED AS µg/l

Sample #	Compound #1	#2	#3	#4	#5	#6	#7	#8	#9	#10	Total Trihalomethanes µg/l	(mg/l)
23897	0.3	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.4	< 0.0004
23899	0.4	2.6	9.0	27.0	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	39	0.039
23898	0.2	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.3	< 0.0003
23900	0.8	4.9	18	53	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	77	0.077
23911	< 0.1	< 0.1	< 0.2	9.9	< 0.1	< 0.1	7.4	< 0.1	< 0.1	< 0.1	10	0.010
23901	190	44	4.6	< 0.2	< 0.3	4.7	< 0.1	< 0.1	< 0.1	< 0.1	239	0.239
23912	1.7	< 0.1	< 0.2	< 0.6	< 0.1	< 0.1	0.5	< 0.1	< 0.1	0.7	3	0.002
23902	2.7	3.3	3.1	0.8	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	10	0.010
23903	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.4	< 0.0004
23904	170	28	0.8	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	199	0.199
23906	0.4	0.6	0.9	0.8	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.2	3	0.002
23905	0.5	0.1	< 0.1	< 0.2	0.4	0.7	0.1	< 0.1	0.8	0.9	4	0.004
23907	0.2	< 0.1	< 0.1	< 0.2	< 0.1	0.1	0.1	< 0.1	< 0.1	0.2	< 0.7	< 0.0007
23908	2.2	9.0	29	61	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.2	97	0.097
23909	Not analyzed											
23910*	635	74	15	1.8	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	1.6	720	0.720
	310	47	9.0	< 0.6	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.5	366	0.366
23913	Not analyzed											
23914	Not analyzed											
Range	< 0.1- 635	< 0.1- 74	< 0.1- 28	< 0.1- 61	< 0.1- 0.4	< 0.1- 4.7	< 0.1 7.4	< 0.1	< 0.1- 0.8	< 0.1- 1.6		0.00- 0.72
Number of positive determinations	14	10	9	7	1	3	3	0	1	7		

The recommended maximum total trihalomethane level is 0.10 mg/l. This is obtained by summing the concentration in columns 1 through 4. F.R. 44, 231, P. 68624 (Nov. 29, 1979).

#1 chloroform
#2 bromodichloromethane
#3 dibromochloromethane
#4 bromoform
#5 cis and trans-1,2-dichloroethylene
#6 1,2-dichloroethane
#7 1,1,1-trichloroethane
#8 carbon tetrachloride
#9 trichloroethylene
#10 tetrachloroethylene

* Duplicate analyses.

waters from groundwater sources in Orange, Texas, and Lake Charles, Louisiana, and from reportedly unchlorinated groundwater in Orange, Texas (site WCID3). (It is likely that this water is also chlorinated.)

A steady increase in trihalomethane levels from chloroform to bromoform is shown by three groundwater systems, while the three surface water systems show a decrease in the more brominated compounds. These trends in the Beaumont-Lake Charles data can be seen more clearly in Figure 12. This observation is consistent with a higher level of bromine-containing natural organics in ground water than in surface water.

Trihalomethanes are used in industrial applications as solvents and may be found in water because of industrial waste disposal. Contribution of THMs in water of the Beaumont-Lake Charles from industrial waste could be explored in future studies.

In 1975, a National Organics Reconnaissance Survey measured levels of chloroform in 80 U.S. water supplies. Chloroform was present in raw water in over one-half (49) of the locations, in concentrations of < 1 µg/l, with the exception of one source that was receiving chlorinated raw water. All of the finished waters tested contained chloroform in concentrations varying from < 0.1 to 311 µg/l (Symons et al. 1975). These results illustrate the magnitude of the THM problem nationwide. Continued research on the reactions of chlorine with organics in drinking water treatment processes, alternative methods of treatment, and the long-term health effects of THMs is needed for adequate protection of public health.

The total trihalomethane recommended level for drinking water is 0.10 mg/l, based on a yearly average of four quarterly results. (For compliance purposes, all samples collected in a quarter are arithmetically averaged and become one compliance concentration for that quarter. Compliance for any quarter is then calculated by arithmetically averaging the four most recent quarterly concentrations.) If this running annual average concentration is equal to or less than 0.10 mg/l, the utility is in compliance. The total trihalomethane values shown in Table 39 are derived from single observations for each site and were not intended for compliance monitoring purposes. These totals may be useful in relative comparisons between sites and in pinpointing locations requiring additional monitoring for organics. Table 40 summarizes the results of organic analyses for the drinking water samples.

ANALYSIS OF SURFACE WATER, SEDIMENT AND FISH TISSUE SAMPLES

Samples of ambient surface water, sediment, and fish tissue were collected at the following sites and dates:

Site	Date	W	S	F
Calcasieu River at				
Moss Lake	3/78	1	1	0
Moss Lake	8/78	1	0	1
Moss Lake	7/80	1	1	0

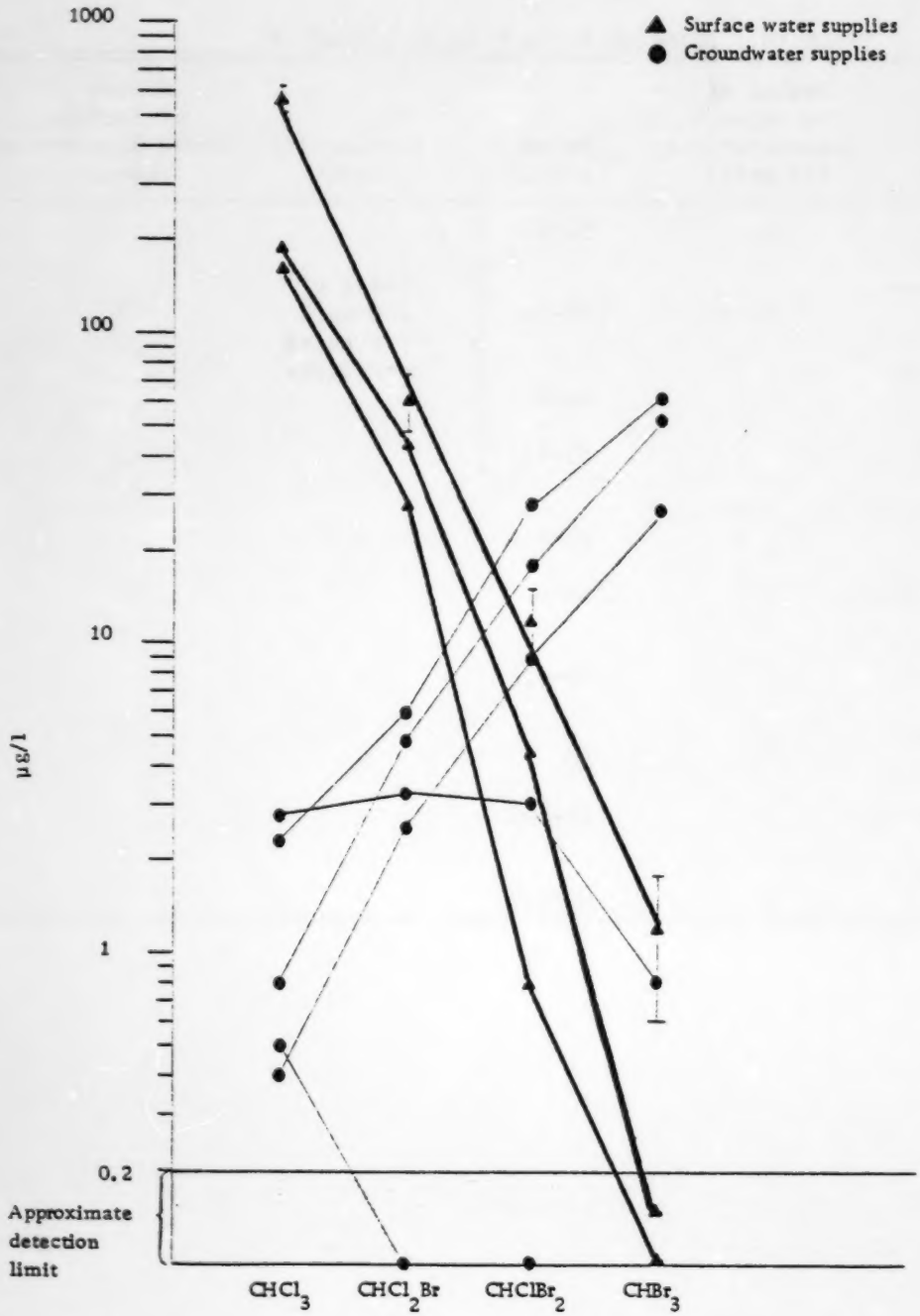


Figure 12. Variation of trihalomethane levels in tap water samples from Beaumont-Lake Charles according to numbers of chlorine atoms and source of supply (surface versus ground)

TABLE 40. DRINKING WATER RESULTS--ORGANICS

Compound	Number of Detectable Concentrations (15 max.)	Range (µg/l)	Recommended Level	Number of Samples Above Recommended Level
Chloroform	13	ND-635	total of 100 µg/l for these compounds	3
Bromodichloromethane	9	ND-74		
Dibromochloromethane	8	ND-28		
Bromoform	7	ND-61		
1,2-Dichloroethylene	1	ND-0.4	-	
1,2-Dichloroethane	2	ND-4.7	-	
1,1,1-Trichloroethane	5	ND-0.5	-	
Carbon tetrachloride	0	ND	-	
Trichloroethylene	1	ND-0.5	-	
Tetrachloroethylene	7	ND-0.9	-	

Site		Date	W	S	F
Calcasieu River at					
	I-10 Bridge	7/80	1	1	0
Neches River at					
	State Hwy 87	8/78	1	1	1
	State Hwy 87	5/80	1	1	1
Sabine River at					
	Channel Marker 3	5/80	1	1	0
Sabine Pass at					
	Coast Guard Station	5/80	1	1	0

In addition, during September 1980 the EPA-Region 6 and Texas Department of Water Resources conducted a toxic study in the Neches River, the Sabine River, and significant tributaries. Twenty-three water, twenty-two sediment and nine fish tissue samples were collected. Tables 41 through 44, contain the results from the 1978 samples plus the water samples from May 1980.

Arsenic in the sediment samples from both the Neches and the Calcasieu in 1978 exceeded the proposed dredge and fill sediment criteria. Zinc levels exceeded the dredge criteria in the Neches. No tissue levels exceeded FDA action levels (note: whole fish, not edible portions, were analyzed). Trace levels of some organics were detected in the surface water samples.

TABLE 41. LEVELS OF CHEMICAL COMPOUNDS IN SURFACE WATER, SEDIMENT AND FISH TISSUE SAMPLES FROM THE NECHES RIVER (August 1978)*

Pollutant	Water	Sediment	Fish Tissue
cyanide	< 0.10 µg/l	< 0.560 mg/kg	< 0.35 mg/kg
arsenic	< 20	11.57	0.17
beryllium	< 20	< 2.2	< 0.4
cadmium	50	< 2.2	2.02
chromium	20	30.97	1.01
copper	35	27.5	11.13
lead	180	48.39	7.96
thallium	< 20	4.05	6.27
nickel	85	22.84	9.92
silver	20	< 2.2	0.4
zinc	40	82	18.00
antimony	22	0.4	0.70
selenium	< 10	< 0.22	0.70
bromoform	< 20	ND	ND
phenols	< 10	< 1.00	< 0.36
methylene chloride	ND	110	0.14
toluene	ND	ND	0.05
Di-n-butyl phthalate	ND	ND	1.450
bis(2-ethylhexyl)phthalate	4	1.640	
Mercury	0.2	0.1	0.16

* Collected at State Highway 87 North of Port Arthur on August 1, 1978 for 129 Priority Pollutant Analysis

TABLE 42. LEVELS OF CHEMICAL COMPOUNDS IN SURFACE WATER, SEDIMENT AND FISH TISSUE SAMPLES FROM THE CALCASIEU RIVER (1978)*

Pollutant	Water	Water	Sediment	Fish Tissue
SAMPLE DATE	3/5/78	8/2/78	3/5/78	8/2/78
cyanide	< 1.7 µg/l	< 0.10 µg/l	< 0.770 mg/kg	< 0.66 mg/kg
arsenic	< 10	27	5.35	0.32
beryllium	< 20	< 20	< 0.18	< 0.430
cadmium	< 20	20	< 0.80	2.41
chromium	40	50	10.90	3.70
copper	190	180	5.96	22.86
lead	40	180	2.67	9.23
thallium	-	< 20	-	8.32
nickel	110	140	8.84	12.52
silver	30	30	< 0.40K	0.650
zinc	240	170	22.60	2.22
antimony	10	< 20	< 0.4	0.83
selenium	< 10	< 10	< 0.4	0.83
phenolics	< 17	< 10	< 0.46	< 0.62
methylene chloride	-	ND	-	0.230
toluene	-	ND	-	35
tetrachloroethylene	-	ND	-	0.035
bis(2-ethylhexyl)phthalate	-	10	-	ND
P,P'DDT	-	ND	0.002	ND
lindane	-	ND	0.002	ND
mercury	< 0.2	< 0.2	0.1	0.17

* Collected at Moss Lake in 1978 for 129 Priority Pollutant Analysis

TABLE 43. LEVELS OF CHEMICAL COMPOUNDS IN SURFACE WATER SAMPLES FROM THE CALCASIEU RIVER (June 1980)*

	I-10 Bridge	Moss Lake
Acenaphthene	<10 µg/l	ND µg/l
1,2,4-trichlorobenzene	<10	ND
1,4-dichlorobenzene	<10	ND
Bis(2-ethylhexyl)phthalate	<10	<10
Di-n-butyl phthalate	<10	<10
Pyrene	<10	ND
Acrolein	<10	ND
Benzene	<10	<10
Chloroform	<10	<10
Methylene chloride	30	<10
Trichlorofluoromethane	<10	ND
Toluene	<10	<10
Aluminum	730	670
Chromium	25	130
Beryllium	2.2	53
Cadmium	<5	<5
Colbalt	42	160
Copper	51	470
Iron	1500	1900
Lead	<40	49
Nickel	<20	28
Manganese	190	160
Zinc	21,000	260
Boron	160	450
Vanadium	27	53
Calcium	36,000	58,000
Magnesium	50,000	110,000
Sodium	60,000	900,000
Arsenic	560	280
Antimony	<20	61
Selenium	37	25
Thallium	<10	<10
Mercury	<1	2.0
Tin	920	2,200
Silver	31	<20

* Collected on June 12, 1980 and analyzed for the 129 Priority in Lake Charles Area

TABLE 44. LEVELS OF CHEMICAL COMPOUNDS IN SURFACE WATER SAMPLES FROM BEAUMONT AREA RIVERS (May 1980)*

	Sabine Pass	Sabine River @ CAN 3	Neches River @ S.H. 87
carbon tetrachloride	ND	ND	< 10 µg/l
chloroform	ND	ND	< 10
methylene chloride	< 10 µg/l	< 10 µg/l	20
trichlorofluoromethane	ND	< 10	ND
bis(2-ethylhexyl)phthalate	< 10	< 10	ND
di-n-butyl phthalate	< 10**	ND**	< 10**
aluminum	< 50	< 50	< 50
Chromium	< 10	< 10	< 19
barium	20	< 10	10
beryllium	50	< 2	< 2
cadmium	< 5	< 5	< 5
cobalt	30	< 10	< 10
copper	960	42	33
iron	1,800	1,800	3,800
lead	< 40	< 40	< 40
nickel	47	< 20	< 20
manganese	66	50	23
zinc	53	50	10
boron	400	290	90
vanadium	26	< 10	< 10
calcium	112,000	9,300	8,300
magnesium	300,000	2,900	3,900
sodium	2,500,000	20,000	21,000
arsenic	130	< 10	< 10
antimony	< 20	< 20	< 20
selenium	75	< 10	20
thallium	< 10	< 10	< 10
mercury	< 1	< 1	< 1
tin	< 20	< 20	< 20
silver	< 20	< 20	< 20

* Collected on May 28, 1980 and analyzed for the 129 Priority Pollutants in the Beaumont Area.

** A trace (<10 µg/l) of di-n-butyl phthalate was found in the sample blank.

SECTION 7

REFERENCES

American Public Health Association. 1976. Standard Methods for the Examination of Water and Wastewater. 14th ed. APHA, Washington, D.C.

Anderson, C.H. and J.M. Long. 1978. Interim Method for Asbestos in Water. Draft submitted to EPA.

Buffler, P.A. 1980. Epidemiology of Primary Liver Cancer in Selected Texas Counties. NCI Contract No. NO1-CP91037. National Cancer Institute.

Gosselink, J.G. 1979. An Ecological Characterization Study of the Chenier Plain Coastal Ecosystem of Louisiana and Texas. FWS/OBS 78/9. U.S. Fish and Wildlife Service.

Kamphake, L.T., S.A. Hannah and J.M. Cohen. 1967. "Automated Analysis for Nitrate by Hydrozine Reduction." (Incomplete references.) Water Research, Vol. I, p. 205-216. Pergamon Press.

McCabe, L.J. and J. Millette. Proc. Amer. Water Works Assoc. Conference, June 24-29, 1979, San Francisco, California 2(1979)1079-1093.

McMillin, C.R., L.B. Mote, and D.G. DeAngelis. 1980. Potential Atmospheric Carcinogens. Phase 1. Identification and Classification. EPA-600/2-80-015. U.S. Environmental Protection Agency, Washington, D.C.

Millette, J.R., R.L. Boone, M.T. Rosenthal, and L.J. McCabe. 1980. The Need to Control Asbestos Fibers in Potable Water Supply Systems. Proc. of the Internal Symposium on Water Supply and Health, Amsterdam, August 27-29, 1980.

Neufeld, L.M. et al. 1978. "Market Input/Output Studies Task V - Benzene Consumption as a Solvent." EPA-560/6-77-034. U.S. Environmental Protection Agency, OTS, U.S. EPA, Washington, D.C.

Pellizzari, E.D. 1974. Development of Methods for Carcinogenic Vapor Analysis in Ambient Atmospheres. 1974. EPA 650/2-74-121.

_____. 1975. Development of Analytical Techniques for Measuring Ambient Atmospheric Carcinogenic Vapors. EPA 600/2-75-076.

_____. 1979. Organic Screening in Lake Charles, Louisiana. Using Gas Chromatography/Mass Spectrometry Techniques. Final Report EPA Contract 68-02-2714.

Pellizzari, E.D. and J.E. Bunch. 1979. Ambient Air Carcinogenic Vapors--Improved Sampling and Analytical Techniques and Field Studies. EPA-600/2-79-081.

Pellizzari, E.D., M.D. Erickson and R.A. Zweidinger. 1979. Formulation of a Preliminary Assessment of Halogenated Organic Compounds in Man and Environmental Media. EPA 560/13-79-006. U.S. EPA, Washington, D.C.

Peoples, A.J., C.D. Pfaffenberger, T.M. Shafik and H.F. Enos. 1979. Determination of Volatile Purgeable Halogenated Hydrocarbons in Human Adipose Tissue and Blood Serum. Bull. Environ. Contam. Toxicol. 23:244-249.

Schock, M.R., G.S. Logsdon and P.J. Clark. 1980. Evaluation and Control of Asbestos-Cement Pipe Corrosion (draft).

Schock, M.R. and R.W. Buelow. 1980. The Behavior of Asbestos-Cement Pipe Under Various Water Quality Conditions--A Progress Report: Theoretical Consideration. (To be submitted to the Journal of the American Water Works Association.)

Schock, M.R., W. Mueller and R. Buelow. 1980. "Laboratory Technique for Measurement of pH for Corrosion Control Studies and Water Not in Equilibrium with the Atmosphere." J. Am. Water Works Assn. pp/ 304-306.

Simms, P.C. and F.A. Rickey. 1978. Multi-elemental Analysis for Drinking Water Using Proton Induced X-ray Emission (PIXIE). EPA 600/178-058.

Symons, J.M. et al. 1975. National Organics Reconnaissance Survey for Halogenated Organics. J. Am. Water Works Assn., November, pp. 634-647.

U.S. Geological Survey. 1978. Methods for Analysis of Inorganic Substances in Water and Fluvial Sediments. USGS Report 78-679.

APPENDIX A

SUMMARY OF CHEMICAL IDENTIFICATIONS IN AMBIENT AIR SAMPLES IN BEAUMONT AND LAKE CHARLES

TABLE A-1. SUMMARY OF COMPOUNDS IDENTIFIED IN VAPOR-PHASE ORGANIC SAMPLES COLLECTED AT LAKE CHARLES, LOUISIANA (June 1978) EMSL-RTP*

Compound	# of times detected	T-131	T-231	T-331	T-141, T-241 T-341	T-142	T-132	T-133	T-143	T-173
chloroethylene	1	+								
carbon dioxide	5	+	+	+		+	+			
isopentane	5	+	+	+		+	+			
acetone	4	+	+	+		+				
C_4H_8O	1	+								
2-methyl pentane	8	+	+	+	+	+	+	+		+
3-methyl pentane	7	+	+	+	+		+	+	+	
4-pentene-2-one	1	+								
n-butanal	2	+						+		
n-hexane	7	+	+	+	+			+	+	+
chloroform	3	+						+		+
2-butanone	5	+	+	+	+					+
C_6H_{12} isomer	2	+	+							
1,1,1-trichloroethane	5	+	+	+	+			+		
benzene	8	+	+	+	+	+	+	+	+	
cyclohexane	9	+	+	+	+	+	+	+	+	+
2-methyl hexane	8	+	+	+	+	+	+	+		+
3-methyl hexane	6	+	+	+	+		+			+
dimethylcyclopentane	7	+	+	+	+		+	+		+
trichloroethylene	8	+	+	+	+	+	+	+		+
C_7H_{16} isomer	1	+								
methyl cyclohexane	9	+	+	+	+	+	+	+	+	+
C_7H_{14} isomer	2	+				+				
1,1,2-trichloroethane	8	+	+		+	+	+	+	+	+
toluene	9	+	+	+	+	+	+	+	+	+
2,3-dimethylhexane	4	+	+	+			+			
2-methyl heptane	8	+	+	+			+	+	+	+
3-methyl heptane	5	+	+	+			+	+		
dimethylcyclohexane	2	+	+							
4-methylcyclohexanone	1	+								

(continued)

* See Table 6 for Sampling Protocol.

TABLE A-1. (continued)

Compound	# of times detected	T-131	T-231	T-331	T-141, T-241, T-341	T-142	T-132	T-133	T-143	T-173
1-Octene	3	+	+					+		
hept-3-ene-2-one	2	+	+							
perchloroethylene	2	+		+						
ethylphenol	2				+					+
$C_{12}H_{26}$ isomer	2				+					+
$C_{12}H_{22}O$ isomer	1				+					
geranylacetone	2				+					+
$C_{14}H_{28}O$ isomer	1				+					
pentadecanone	1				+					
pentadecanal	1				+					
ethyl phthalate	1				+					
$C_{14}H_{20}$ isomer	1				+					
2-undecanone	1				+					
dibutylphthalate	1				+					
eicosane	2				+	+				
C_4H_8 isomer	1					+				
C_5H_{12} isomer	1					+				
C_6H_{14} isomer	1					+				
dibromochloromethane	3					+			+	+
C_8H_{16} isomer	4					+	+	+		+
alkane	1					+				
C_9H_{20} isomer	3					+	+	+		
o-xylene	5					+	+	+	+	+
C_9H_{18} isomer	1					+				
C_7H_6O isomer	1					+				
$C_{11}H_{24}$ isomer	1									
2-methyldodecane	1					+				
$C_{15}H_{32}$ isomer	1					+				
C_3 naphthalene	1					+				
$C_{19}H_{40}$ isomer	1					+				

(continued)

TABLE A-1. (continued)

Compound	# of times detected	T-131	T-231	T-331	T-141, T-241, T-341	T-142	T-132	T-133	T-143	T-173
$C_{20}H_{40}$	1					+				
isobutene	1						+			
methyl nitrate	1						+			
ethylacetate	3			+	+			+		
C_5H_{12} O isomer	1		+			+			+	
2,3-dimethylpentane	1			+						
n-octane	2			+			+			
$C_8H_{14}O$	1			+						
1-nonene	2			+						
benzaldehyde	2			+	+					
$C_{10}H_{20}$ isomer	1		+							
1-undecane	4			+	+					+
1-dodecane	5			+	+	+			+	+
1-tridecane	3			+	+		+		+	
1-pentadecane	2			+	+	+			+	
$C_{16}H_{34}$ isomer	1		+		+			+		
1-heptadecane	1			+						
$C_{17}H_{36}$ isomer	3			+			+	+	+	
1-octadecane	1			+						
n-octy-o-phthalate	1			+						
$C_{18}H_{36}O$ isomer	1			+		+				
1,2-dichloroethane	4				+			+	+	+
2,4-dimethylhexane	1				+					
dimethycyclopentanone	1				+					
p-xylene	4				+	+			+	+
b-pinene	1				+					
1-decene	2				+		+			
2,3-dimethylphenol	1				+					
alkylbenzene	1				+					

(continued)

TABLE A-1. (continued)

Compound	# of times detected	T-131	T-231	T-331	T-141, T-241, T-341	T-142	T-132	T-133	T-143	T-173
phenol	1				+					+
$C_8H_{10}O$ isomer	1				+					
C_8H_{10} isomer	1				+					
nathalene	5				+		+			+
3,4-dimethylphenol	2				+					+
phenalene	4	+	+			+			+	
fluorene	7	+	+	+	+	+			+	+
n-hexadecane	6	+	+	+		+			+	+
$C_{17}H_{34}$ isomer	3	+			+					+
$C_{17}H_{35}$ isomer	1		+							
n-heptadecane	6	+	+	+	+	+				+
$C_{18}H_{38}$ isomer	5	+		+		+			+	+
n-octadecane	6	+	+		+	+			+	+
n-nonadecane	5	+	+	+	+	+				
phthalic acid ester	2	+			+					
$20H_{42}$ isomer	4	+	+	+	+					
carbon disulfide	2		+	+						
methylcyclopentane	3		+		+				+	
n-heptane	5		+		+	+		+		+
C_8H_{18} isomer	6		+			+	+	+	+	
2,2,4-trimethylhexane	1		+							
tetrachloroethylene	3		+		+				+	
acetic acid	4		+	+	+	+				
$C_6H_8O_3Si_3$	1		+							
bromoform	1		+							
$C_{10}H_{22}$ isomer	3		+						+	+
acetophenone	3	+	+							+
$C_{13}H_{28}$ isomer	2	+				+				
n-tridecane	5		+	+	+				+	+

(continued)

TABLE A-1. (continued)

Compound	# of times detected	T-131	T-231	T-331	T-141 T-241 T-341	T-142	T-132	T-133	T-143	T-173
2-methylheptadecane	1	+								
silanes	1	+								
dibutylphthalate	1	+								
nitrogen dioxide	1			+						
isobutane	1			+						
n-butane	3			+				+	+	
C_3H_8 isomer	1			+						
acetaldehyde	2			+		+				
2,3-dimethylbutane	1			+						
n-pentanal	1			+						
dimethyldifluorosilane	1						+			
n-pentane	2						+	+		
3-methylbutanal	1						+			
methylvinyl ketone	1						+			
methylcyclopentane	2						+			+
1-methyl-cis-3-ethyl-cyclopentane	1						+			
2,2,3,3-tetramethylbutane	4						+	+	+	+
cyclooctatraene	2						+		+	
$C_{10}H_{22}$ isomer n-tridecane	1						+			
1,1,1,2-tetrachloroethane	3						+	+		+
m-xylene	1							+		
a-xylene	2							+	+	
1,1,2,2-tetrachloroethane	1								+	
1-pentene	1								+	
dimethylbutane	1								+	
2,4-dimethylpentane	1								+	
2-methyl-2-pentanone	1								+	
3-decene	1								+	

(continued)

TABLE A-1. (continued)

Compound	# of times detected	T-131	T-231	T-331	T-141, T-241, T-341	T-142	T-132	T-133	T-143	T-173
$C_{18}H_{36}$ isomer	2								+	+
2-methylpropanal	1									+
3-methylpentanal	1									+
perfluorbenzene	1									+
perfluorotoluene	1									+
3-methyl-2-pentanone	1									+
dimethyldisulfide	1									+
1,2-bromoethane	1									+
1,2-dibromopropane	1									+
2,6-dimethylheptane	1									+
1,1,1,-2 tetrachloro-2,2-difluoroethane	1									+
benzonitrile	1									+
4-methyl-5-hepten-5-one	1									+
C_4-alkylbenzene	1									+
cresol	1									+
chlorobenzene	4	+					+		+	+
C_9H_{18} isomer	3	+					+		+	
ethylbenzene	7	+		+	+	+	+	+		+
xylene	2		+							
2-methyl octane	3	+					+	+		
3-methyl octane	1	+								
styrene	2	+				+				
1-methyl-4-ethyl-cyclohexane	1	+								
n-nonane	8	+	+	+	+	+	+		+	+
α-pinene	8	+	+	+	+	+	+		+	+
phenylacetaldehyde	5	+				+	+		+	+
C_3-alkylbenzene	6	+	+			+	+		+	+

(continued)

TABLE A-1. (concluded)

Compound	# of times detected	T-131	T-231	T-331	T-141 T-241 T-341	T-142	T-132	T-133	T-143	T-173
2-methyl nonane	1	+								
$C_{10}H_{16}$ isomer	3	+				+	+			
$C_{10}H_{20}$ isomer	3	+	+		+					
n-decane	8	+	+	+	+	+	+		+	+
α-limonene	4	+					+		+	+
2,2,4-trimethylheptane	2	+			+					
$C_{11}H_{24}$ isomer	5	+	+			+	+		+	
ethyl styrene	1	+								
$C_{11}H_{22}$ isomer	4	+	+						+	+
n-undecane	8	+	+	+	+	+	+		+	+
$C_{10}H_{14}$ isomer	1	+								
$C_{12}H_{24}$ isomer	2	+	+							
n-dodecane	8	+	+	+	+	+	+		+	+
methyl napthalene	4	+	+	+					+	
$C_{13}H_{26}$ isomer	3	+			+			+		
$C_{14}H_{28}$ isomer	5	+			+	+			+	+
n-tetradecane	7	+	+	+	+	+			+	+
$C_{14}H_{30}$ isomer	2	+				+				
$C_{15}H_{30}$ isomer	4	+	+		+	+				
n-pentadecane	7	+	+	+	+	+			+	+
dimethylphenol	1									+
2,4-dimenthylphenol	1									+
diethyl-o-phthalate	1									+
di-isobutylphthlate	1									+
$C_{20}H_{42}$ isomer	1									+

TABLE A-2. SUMMARY OF COMPOUNDS IDENTIFIED IN VAPOR-PHASE ORGANIC SAMPLES COLLECTED AT LAKE CHARLES (June 1978) ORNL*

Compound	No. of times Detected	Date Collected: 6/23-24/78 T-151	T-251	T-161	T-261	T-361	6/24-25/78 T-162	6/25-26/78 T-153	T-163
carbon dioxide	8	+	+	+	+	+	+	+	+
oxide of nitrogen	4	+	+		+			+	
dichlorodifluoromethane	2		+				+		
2-methylpropane	1				+				
isobutane	2						+	+	
n-butane	1						+		
2-methylbutane	2				+	+			
isopentane	2						+	+	
n-pentane	2						+	+	
trichlorofluoromethane	5	+	+	+	+	+			
acetone	7	+	+	+	+	+		+	+
diethyl ether	7	+	+	+	+	+	+		+
methylene chloride	8	+	+	+	+	+	+	+	+
dimethylbutane	3	+			+	+			
2-methylpentane	7	+	+	+	+	+		+	+
3-methylpentane	6	+	+		+	+		+	+
n-hexane	6	+	+		+	+		+	+
chloroform	4		+			+	+	+	
ethyl acetate	2		+					+	
tetrahydrofuran	2	+				+			
methylcyclopentane	5	+	+			+		+	+
3-methyl-1-pentene	1				+				
1,2-dichloroethane	1							+	
2-ethyl-1-butene	2		+						+

(continued)

* See Table 6 for Sampling Protocol.

TABLE A-2. (continued)

Compound	No. of times Detected	Date Collected: 6/23-24/78 T-151	T-251	T-161	T-261	T-361	6/24-25/78 T-162	6/25-26/78 T-153	T-163
1,1,1-trichloroethane	2					+		+	
2,4-dimethylpentane	3		+		+	+			
methyl tetrahydrofuran	1		+						
benzene	8	+	+	+	+	+	+	+	+
divinylacetylene	2		+				+		
cyclohexane	7	+	+		+	+	+	+	+
2-methylhexane	6	+	+		+	+		+	+
3-methylhexane	6	+	+		+	+		+	+
trichloroethylene	4		+	+	+	+			
dimethylhexane	1		+						
hexamethyl disiloxane	5		+	+	+	+	+		
n-heptane	5	+	+	+	+	+			
dimethylpentene	1			+					
methylcyclohexane	6	+	+		+	+	+		+
1,1,2-trichloroethane	2	+							+
toluene	7	+	+	+	+	+	+		+
2-methylheptane	1	+							
3-methylheptane	1	+							
tetrachloroethylene	6	+	+	+			+	+	+
n-octane	6	+	+	+		+	+		+
furaldehyde	1	+							
trimethylcyclohexane	1		+						
ethylcyclohexane	1	+							
1,1,1,2-tetrachloroethane	1	+							
ethyl benzene	1	+							

(continued)

TABLE A-2. (continued)

Compound	No. of times Detected	Date Collected: 6/23-24/78 T-151	T-251	T-161	T-261	T-361	6/24-25/78 T-162	6/25-26/78 T-153	T-163
hexamethylcyclohexasiloxane	1		+						
bromoform	2	+							+
xylene	4	+	+				+		+
styrene	2		+				+		
2,6-dimethylheptane	1	+							
3,5-dimethylheptane	1	+							
heptaldehyde	1		+						
xylene	1	+							
n-nonane	4	+	+		+		+		
α-pinene	3	+	+		+				
benzaldehyde	2	+	+						
phenylacetaldehyde	1	+							
trimethylbenzene	1	+							
β-pinene	1	+							
$C_{10}H_{22}$	2	+	+						
acetophenone	2		+		+				
trimethyl benzene	1	+							
n-nonanal	1		+						
n-decane	2	+					+		
decanal	1		+						
C_3-benzene	1	+							
C_4-benzene	1	+							
2,6-dimethyloctane	1	+							
2,2,3-trimethylhexane	1	+							
$C_{10}H_{22}$	1	+							

(continued)

TABLE A-2. (continued)

Compound	No. of times Detected	Date Collected: 6/23-24/78 T-151	T-251	T-161	T-261	T-361	6/24-25/78 T-162	6/25-26/78 T-153	T-163
methyl isopropyl benzene	1	+							
2,6-dimethyloctane	1	+							
$C_{10}H_{22}$	1	+							
$C_{11}H_{24}$	2	+					+		
n-undecane	2	+					+		
dimethyl phenol	1	+							
ethyl phenol	1	+							
naphthalene	1	+							
a silicon cmpd.	2	+							+
n-dodecane	3	+			+		+		
a silicon cmpd	1	+							
C_nH_{2n+2}	2	+							+
a silicon cmpd.	1	+							
n-tridecane	1	+							
a silicon cmpd.	1	+							
$C_{13}H_{28}$	1	+							
C_nH_{2n+2}	1	+							
diethyl phthalate	2	+	+						
C_nH_{2n+2}	2	+					+		
butyric anhydride	1						+		
C_nH_{2n+2}	2	+	+						
C_nH_{2n+2}	3	+	+						
di-n-propyl phthalate	1	+							
di-n-butyl phthalate	3		+				+		+
dioctyl adipate	1		+						
C_nH_{2n+2}	1						+		

TABLE A-3. SUMMARY OF COMPOUNDS IDENTIFIED IN VAPOR-PHASE ORGANIC SAMPLES COLLECTED AT LAKE CHARLES-RTI*

Compound	Number of times detected	Day 1		Day 2		Day 3
		T111, 211, 311	T121	T112	T172	T113
isobutane	1	+				
vinyl chloride	1	+				
C_4H_8 isomer	5	+	+	+	+	+
acetaldehyde	5	+	+	+	+	+
methyl formate	1	+				
isopentane	5	+	+	+	+	+
acetone	5	+	+	+	+	+
n-pentane	3	+			+	+
methylene chloride	5	+	+	+	+	+
CS_2	2	+	+			
C_4H_8O isomer	3	+		+		+
C_5H_{10} isomer	4	+	+	+	+	
2-methyl pentane	5	+	+	+	+	+
butanal	4	+	+	+	+	
3-methyl pentane	5	+	+	+	+	+
methyl ethyl ketone	5	+	+	+	+	+
C_6H_{12} isomer	3	+	+		+	
Hexafluorobenzene	4	+	+		+	+
n-hexane	5	+	+	+	+	+
ethyl acetate	3	+	+			+
chloroform	5	+	+	+	+	+
C_7H_{16} isomer	3	+	+		+	
perfluorotoluene	4		+	+	+	+
methylcyclopentane	5	+	+	+	+	+
1,2-dichloroethane	3	+	+			+
1,1,1-trichloroethane	5	+	+	+	+	+
methyl isopropyl ketone	2	+	+			
benzene	5	+	+	+	+	+
1-butanol	2	+	+			
carbon tetrachloride	5	+	+	+	+	+
cyclohexane	5	+	+	+	+	+
2-methylhexane	5	+	+	+	+	+
2,3-dimethylpentane	4	+	+		+	+
3-methylhexane	5	+	+	+	+	+
n-pentanal	5	+	+	+	+	+

* See Table 10 for sampling protocol.

TABLE A-3. (Continued)

Compound	Number of times detected	Day 1		Day 2		Day 3
		T111, 211, 311	T121	T112	T172	T113
C_7H_{14} isomer	5	+	+	+	+	+
trichloroethylene	5	+	+	+	+	+
C_8H_{18} isomer	5	+	+	+	+	+
n-heptane	4	+	+	+	+	
methylcyclohexane	4	+	+	+	+	
C_8H_{16} isomer	5	+	+	+	+	+
1,1,2-trichloroethane	5	+	+	+	+	+
toluene	5	+	+	+	+	+
n-hexanal	3	+		+		+
dibromochloromethane	3	+	+			+
n-octane	5	+	+	+	+	+
tetrachloroethylene	5	+	+	+	+	+
furfural	5	+	+	+	+	+
C_9H_{20} isomer	5	+	+	+	+	+
1,1,1,2-tetrachloroethane	2	+	+			
ethylcyclohexane	4	+	+	+		+
chlorobenzene	3	+	+		+	
C_9H_{18} isomer	5	+	+	+	+	+
ethylbenzene	5	+	+	+	+	+
xylene isomer	5	+	+	+	+	+
bromoform	4	+	+	+		+
$C_7H_{14}O$ isomer	2	+	+			
styrene	5	+	+	+	+	+
n-heptanal	3	+	+		+	
o-xylene	5	+	+	+	+	+
n-nonane	5	+	+	+	+	+
$C_{10}H_{20}$ isomer	4	+	+		+	+
isopropylbenzene	5	+	+	+	+	+
$C_{10}H_{22}$ isomer	5	+	+	+	+	+
C_3-alkyl cyclohexane	1	+				
$C_{10}H_{16}$ isomer	4	+	+		+	+
benzaldehyde	5	+	+	+	+	+
n-propylbenzene	5	+	+	+	+	+
ethyltoluene isomer	5	+	+	+	+	+
benzonitrile	4	+	+	+	+	

(continued)

TABLE A-3. (Continued)

Compound	Number of times detected	Day 1		Day 2		Day 3
		T111, 211, 311	T121	T112	T172	T113
1,3,5-trimethylbenzene	5	+	+	+	+	+
phenol	5	+	+	+	+	+
$C_8H_{16}O$ isomer	1	+				
o-ethyltoluene	5	+	+	+	+	+
$C_{10}H_{16}$ isomer	4	+	+	+	+	
$C_{11}H_{24}$ isomer	5	+	+	+	+	+
n-octanal	5	+	+	+	+	+
1,2,4-trimethylbenzene	5	+	+	+	+	+
n-decane	5	+	+	+	+	+
dichlorobenzene isomer	5	+	+	+	+	+
$C_{11}H_{22}$ isomer	3	+	+			+
C_4-alkyl benzene isomer	5	+	+	+	+	+
2-ethyl-1-hexanol	2	+	+			
1,2,3-trimethylbenzene	4	+	+	+		+
indan	1	+				
$C_{12}H_{26}$ isomer	5	+	+	+	+	+
acetophenone	5	+	+	+	+	+
$C_{12}H_{24}$ isomer	5	+	+	+	+	+
n-nonanol	5	+	+	+	+	+
n-undecane	5	+	+	+	+	+
C_5-alkyl benzene isomer	5	+	+	+	+	+
$C_{13}H_{28}$ isomer	3	+	+	+		
C_2-alkyl phenol isomer	4	+		+	+	+
$C_{11}H_{20}$ isomer	2	+	+			
methylacetophenone isomer	4	+	+	+		+
$C_{10}H_{20}$ isomer	2	+			+	
naphthalene	5	+	+	+	+	+
n-decanal	5	+	+	+	+	+
n-dodecane	5	+	+	+	+	+
$C_{11}H_{22}O$ isomer	1	+				
n-undecanal	5	+	+	+	+	+
n-tridecane	5	+	+	+	+	+
3-methylnaphthalene	5	+	+	+	+	+
a-methylnaphthalene	5	+	+	+	+	+
alkyl butyrate	5	+	+	+	+	+
biphenyl	2	+	+			

(continued)

TABLE A-3. (Continued)

Compound	Number of times detected	Day 1		Day 2		Day 3
		T111, 211, 311	T121	T112	T172	T113
$C_{14}H_{28}$ isomer	5	+	+	+	+	+
n-dodecanal	3	+			+	+
diphenyl ether	3	+	+		+	
n-tetradecane	5	+	+	+	+	+
C_2-alkyl naphthalene isomer	5	+	+	+	+	+
$C_{13}H_{26}O$ isomer	1	+				
$C_{15}H_{30}$ isomer	2	+	+			
n-pentadecane	5	+	+	+	+	+
diethyl phthalate	3	+		+		+
$C_{14}H_{28}O$ isomer	1	+				
$C_{16}H_{32}$ isomer	5	+	+	+	+	+
n-hexadecane	5	+	+	+	+	+
tributyl phosphate	4	+	+	+	+	
$C_{15}H_{30}O$ isomer	1	+				
n-heptadecane	5	+	+	+	+	+
n-octadecane	2	+	+			
propane	1		+			
C_4H_{10} isomer	1				+	
methyl propenal	1		+			
C_4H_6O isomer	1					+
C_7H_{12} isomer	1		+			
$C_6H_{12}O$ isomer	1		+			
di-n-propyl ether	0					
2-ethyl-1-hexanol	0					
C_4H_7 benzene isomer	1		+			
1,3-hexachlorobutadiene	1		+			
$C_{14}H_{30}$ isomer	3		+		+	+
$C_{15}H_{32}$ isomer	3		+		+	+
$C_{17}H_{36}$ isomer	1		+			
C_3-alkyl naphthalene isomer	1		+			
C_5H_8 isomer	1		+			
crotonaldehyde	1		+			
cyclopentane	2		+			+
$C_5H_{10}O$ isomer	2		+			+
acetic acid	2			+	+	
$C_{13}H_{26}$ isomer	2		+			
methyl vinyl ketone	2				+	+

(continued)

TABLE A-3. (Continued)

Compound	Number of times detected	Day 1		Day 2		Day 3
		T111, 211, 311	T121	T112	T172	T113
1,2-dibromopropane	1				+	
alkyl acid	2		+		+	
1,1,2,2-tetrachloroethane	2				+	+
C_3-alkyl phenol isomer	1				+	
lauric acid	1				+	
chloroethylene	1					+
propylcyclohexane	1					+
C_4H_8O aldehyde isomer	1				+	
methyl propanal isomer	1				+	
1,2-dibromoethane	1				+	

TABLE A-4. SUMMARY OF VAPOR-PHASE ORGANICS IDENTIFIED IN AMBIENT AIR FROM LAKE CHARLES (February 1979) RTI*

Chemical	# of times detected	SITE P7/L3 (2h)	P8/L1 (1h)	P3/L1 (1h)	P4/L1 (1h)
xenon	4	+	+	+	+
CF_2Cl_2	1	+			
vinyl chloride	2	+		+	
C_4H_8 isomer	4	+	+	+	+
C_4H_{10} isomer	1	+			
acetaldehyde	4	+	+	+	+
ethyl chloride	1	+			
isopentane	4	+	+	+	+
$CFCl_3$	1	+			
n-pentane	4	+	+	+	+
acetone	4	+	+	+	+
vinylidene chloride	2	+		+	
methylene chloride	4	+	+	+	+
freon 113	1	+			
dichloroethylene isomer	2	+		+	
C_5H_{10} isomer	3	+	+		+
2-methyl pentane	4	+	+	+	+
3-methyl pentane	4	+	+	+	+
C_6H_{12} isomer	3	+	+		+
hexafluorobenzene	4	+	+	+	+
dichloroethylene isomer	2	+		+	
n-hexane	4	+	+	+	+
methyl ethyl ketone	3	+		+	+
chloroform	4	+	+	+	+
ethyl acetate	4	+	+	+	+
perfluorotoluene	4	+	+	+	+
methylcyclopentane	3	+	+		+
1,2-dichloroethane	4	+	+	+	+

* See Table 18 for sampling protocol.

(continued)

TABLE A-4. (continued)

Chemical	# of times detected	SITE P7/L3 (2h)	P8/L1 (1h)	P3/L1 (1h)	P4/L1 (1h)
1,1,1-trichloroethane	4	+	+	+	+
benzene	4	+	+	+	+
carbon tetrachloride	4	+	+	+	+
cyclohexane	4	+	+	+	+
2-methylhexane	4	+	+	+	+
3-methylhexane	4	+	+	+	+
$C_5H_{10}O$ isomer	2	+			+
C_7H_{14} isomer	3	+	+		+
trichloroethylene	4	+	+	+	+
n-heptane	4	+	+	+	+
acetic acid	2	+		+	
methylcyclohexane	4	+	+	+	+
C_8H_{18} isomer	4	+	+	+	+
1,1,2-trichloroethane	3	+		+	+
toluene	4	+	+	+	+
C_8H_{16} isomer	3	+	+	+	+
n-octane	4	+	+	+	+
tetrachloroethylene	4	+	+	+	+
C_9H_{20} isomer	4	+	+	+	+
C_9H_{18} isomer	4	+	+	+	+
1,1,1,2-tetrachloroethane	2	+		+	
chlorobenzene	3	+		+	+
ethylbenzene	4	+	+	+	+
xylene isomer	4	+	+	+	+
o-xylene	4	+	+	+	+
1,1,2,2-tetrachloroethane	2	+		+	
n-nonane	4	+	+	+	+
$C_{10}H_{22}$ isomer	4	+	+	+	+
isopropylbenzene	4	+	+	+	+
C_3-alkyl cyclohexane isomer	1	+			
n-propylbenzene	3	+	+		+
ethyltoluene isomer	2	+	+		

(continued)

TABLE A-4. (continued)

Chemical	# of times detected	SITE P7/L3 (2h)	P8/L1 (1h)	P3/L1 (1h)	P4/L1 (1h)
1,3,5-trimethylbenzene	2	+	+		
$C_{11}H_{24}$ isomer	3	+	+	+	
pentachloroethane	1	+			
benzaldehyde	3	+	+		+
o-ethyltoluene	3	+	+		+
$C_{10}H_{20}$ isomer	3	+	+		+
1,2,4-trimethylbenzene	2	+	+		
n-decane	2	+	+		
C_4-alkyl benzene isomer	4	+	+	+	+
dichlorobenzene isomer	3	+	+		+
$C_{11}H_{22}$ isomer	3	+		+	+
1,2,3-trimethylbenzene	3	+	+		+
acetophenone	3	+	+		+
pentachlorobromomethane	1	+			
C_4H_7-benzene isomer	3	+	+	+	
n-undecane	3	+	+		+
$C_{12}H_{26}$ isomer	4	+	+	+	+
C_5-alkyl benzene isomer	4	+	+	+	+
$C_{12}H_{24}$ isomer	4	+	+	+	+
C_6-alkyl cyclohexane isomer	3	+		+	+
pentachlorobutadiene	1	+			
naphthalene	4	+	+	+	+
n-dodecane	4	+	+	+	+
$C_{13}H_{28}$ isomer	3	+		+	+
hexachlorobutadiene	1	+			
$C_{14}H_{30}$ isomer	3	+		+	+
n-tridecane	3	+	+		+
α-methylnaphthalene	3	+	+		+
β-methylnaphthalene	3	+	+		+
biphenyl	2	+		+	
n-tetradecane	4	+	+	+	+
diphenyl ether	1			+	
$C_{15}H_{32}$ isomer	2			+	+

(continued)

TABLE A-4. (continued)

Chemical	# of times detected	SITE P7/L3 (2h)	P8/L1 (1h)	P3/L1 (1h)	P4/L1 (1h)
$C_{11}H_{24}$ isomer	2		+		+
$C_{10}H_{18}$ isomer	2		+		+
$C_{13}H_{26}$ isomer	3		+	+	+
isobutane	2		+		+
n-butane	2		+		+
cyclopentane	2		+		+
C_6H_{10} isomer	1		+		
2,3-dimethylpentane	3		+	+	+
pentanal	1		+		
dimethylcyclohexane	1		+		
ethylcyclohexane	1		+		
$C_6H_{12}O$	1		+		
styrene	2	+	+		
propylcyclohexane	1		+		
$C_{10}H_{16}$ isomer	2		+		+
$C_{12}H_{24}$ isomer	1		+		
butane	1			+	
chloroethane	1			+	
1,1-dichloroethane	1		+		
butanal	1		+		
4-methyl-2-pentanone	1			+	
dibromocloromethane	1			+	
trichloropropane	1			+	
bromoform	1			+	
C_9H_{16} isomers	2			+	+
decahydro-2-methylnaphthalene	2			+	+
trichlorobenzene isomer	1			+	
$C_{12}H_{22}$ isomer	2			+	+
1,3-hexachlorobutadiene	1			+	
$C_{14}H_{28}$ isomer	2			+	+
C_7-alkyl cyclohexane isomer	2			+	+
$C_{15}H_{28}$ isomer	1			+	

(continued)

TABLE A-4. (concluded)

Chemical	# of times detected	SITE P7/L3 (2h)	P8/L1 (1h)	P3/L1 (1h)	P4/L1 (1h)
$C_{15}H_{30}$ isomer	2			+	+
$C_{16}H_{34}$ isomer	2			+	+
n-pentadecane	2			+	+
propane	1				+
methanol	1				+
isopropanol	1				+
1-hexene	1				+
C_7H_{16} isomer	1				+
C_8H_{14} isomer	1				+
C_8H_{16} isomer	1				+
$C_7H_{14}O$ isomer	1				+
propylcyclohexane	1				+
2,3,5-trimethylbenzene	1				+
n-decane	1				+
butylcyclohexane	1				+
$C_{11}H_{20}$ isomer	1				+
C_5-alkylcyclohexane isomer	1				+

TABLE A-5. SUMMARY OF VAPOR-PHASE ORGANICS IDENTIFIED IN AMBIENT AIR FROM BEAUMONT TEXAS (March-April 1979) RTI†

Chemical	# of times detected	SITE P2/L2*	P4/L3*	P3/L3*	P5/L1*	P6/L2*	P1/L1**	P5/L1*
xenon	6	+	+		+	+	+	+
chloromethane	3	+					+	+
isobutane	4	+				+	+	+
C_4H_8 isomer	7	+	+	+	+	+	+	+
acetaldehyde	6	+		+	+	+	+	+
n-butane	4	+				+	+	+
isopentane	7	+	+	+	+	+	+	+
n-pentane	4	+	+	+				+
acetone	7	+	+	+	+	+	+	+
methylene chloride	7	+	+	+	+	+	+	+
isopropanol	7	+	+	+	+	+	+	+
cyclopentane	4	+		+	+			+
2-methylpentane	7	+	+	+	+	+	+	+
3-methylpentane	7	+	+	+	+	+	+	+
n-butanal	4	+	+				+	+
hexafluorobenzene	7	+	+	+	+	+	+	+
n-hexane	7	+	+	+	+	+	+	+
C_6H_{12} isomer	5	+	+		+	+		+
chloroform	7	+	+	+	+	+	+	+
methyl ethyl ketone	6	+	+	+		+	+	+
ethyl acetate	6	+	+	+	+	+	+	
perfluorotoluene	7	+	+	+	+	+	+	+
1,1,1-trichloroethane	7	+	+	+	+	+	+	+
benzene	7	+	+	+	+	+	+	+
carbon tetrachloride	7	+	+	+	+	+	+	+
cyclohexane	7	+	+	+	+	+	+	+
2-methyl hexane	7	+	+	+	+	+	+	+
2,3-dimethyl pentane	6	+		+	+	+	+	+
C_7H_{14} isomer	7	+	+	+	+	+	+	+

* 2-h samples (Table 22)

** 48-h samples (Table 23)

† See Tables 22 and 23 for sampling protocols.

(continued)

TABLE A-5. (continued)

Chemical	# of times detected	SITE P2/L2*	P4/L3*	P3/L3*	P5/L1*	P6/L2*	P1/L1**	P5/L1**
$C_{11}H_{24}$ isomer	7	+	+	+	+	+	+	+
o-ethyltoluene	2	+	+					
phenol	5	+		+		+	+	+
benzonitrile	4	+		+			+	+
1,2,4-trimethylbenzene	5	+	+		+		+	+
n-decane	7	+	+	+	+	+	+	+
dichlorobenzene isomer	7	+	+	+	+	+	+	+
C_4-alkyl benzene isomer	6	+	+	+	+		+	+
1,2,3-trimethylbenzene	6	+	+	+		+	+	+
1,3,4-trimethylbenzene	1							+
acetophenone	7	+	+	+	+	+	+	+
$C_{10}H_{18}$ isomers	1	+						
C_5-alkyl benzene isomer	4	+			+		+	+
n-undecasne	7	+	+	+	+	+	+	+
$C_{12}H_{26}$ isomer	5	+		+	+		+	+
$C_{11}H_{20}$ isomer	3	+	+				+	
$C_{11}H_{22}$ isomer	7	+	+	+	+	+	+	+
trichlorobenzene isomer	2	+				+		
$C_{12}H_{24}$ isomer	7	+	+	+	+	+	+	+
naphthalene	7	+	+	+	+	+	+	+
n-dodecane	7	+	+	+	+	+	+	+
$C_{13}H_{28}$ isomer	5	+	+	+			+	+
C_6-alkyl benzene isomer	1	+						
$C_{13}H_{16}$ isomer	6	+	+	+		+	+	+
C_6-alkyl cyclohexane isomer	2	+						+
$C_{14}H_{30}$ isomer	6	+	+	+	+		+	+
n-tridecane	6	+	+	+		+	+	+
methylnaphthalene	4	+	+	+			+	
$C_{15}H_{32}$ isomer	3	+		+				+

(Continued)

TABLE A-5. (continued)

Chemical	# of times detected	SITE P2/L2*	P4/L3*	P3/L3*	P5/L1*	P6/L2*	P1/L1**	P5/L1**
$C_{14}H_{28}$ isomer	2	+					+	
C_7-alkyl cyclohexane isomer	1	+						
alkyl butyrate	7	+	+	+	+	+	+	+
n-tetradecane	4	+				+	+	+
$C_{15}H_{30}$ isomer	4	+		+		+	+	
n-pentadecane	4	+				+	+	+
C_5-alkyl cyclohexane isomer	1						+	
propane	3		+	+		+		
butene isomer	1		+					
butadiene	1		+					
C_4H_{10} isomer	3		+	+	+			
C_4H_6 isomer	2		+	+				
C_5H_{10} isomer	3		+				+	+
C_5H_8 isomer	1		+					
decamethylcyclopenta-siloxane	2						+	+
diethyl phthalate	1						+	
$C_{10}H_{16}$ isomer	1							+
ter-butanol	3		+				+	+
C_7H_{12} isomer	1		+					
C_6H_{10} isomer	2		+		+			
pentanal	1		+					
diisobutylene	1		+					
C_8H_{14} isomer	1		+					
hexanal	1		+					
4-vinyl-1-cyclohexene	1		+					
C_9H_{16} isomer	2		+				+	
triisobutylene	1		+					
C_9H_{18} O isomer	1		+					

(continued)

TABLE A-5. (continued)

Chemical	# of times detected	SITE P2/L2*	P4/L3*	P3/L3*	P5/L1*	P6/L2*	P1/L1**	P5/L1**
3-methylhexane	7	+	+	+	+	+	+	+
C_5H_{12} isomer	1							+
$CFCl_3$	1							+
deuterotrichloromethane	1							+
trichloroethylene	7	+	+	+	+	+	+	+
n-heptane	7	+	+	+	+	+	+	+
C_8H_{18} isomer	7	+	+	+	+	+	+	+
methylcyclohexane	7	+	+	+	+	+	+	+
C_8H_{16} isomer	7	+	+	+	+	+	+	+
C_6H_{12} O isomer	3	+		+			+	
toluene	7	+	+	+	+	+	+	+
n-octane	7	+	+	+	+	+	+	+
tetrachloroethylene	7	+	+	+	+	+	+	+
ethylcyclohexane	4	+				+	+	+
C_9H_{20} isomer	7	+	+	+	+	+	+	+
chlorobenzene	4	+		+			+	+
C_9H_{18} isomer	7	+	+	+	+	+	+	+
ethylbenzene	7	+	+	+	+	+	+	+
xylene isomer	7	+	+	+	+	+	+	+
styrene	6	+	+	+	+		+	+
o-xylene	7	+	+	+	+	+	+	+
n-nonane	6	+	+	+	+		+	+
$C_{10}H_{30}$ isomer	7	+	+	+	+	+	+	+
$C_{10}H_{22}$ isomer	7	+	+	+	+	+	+	+
isopropyl benzene	6	+	+	+	+		+	+
n-propylbenzene	7	+	+	+	+	+	+	+
benzaldehyde	7	+	+	+	+	+	+	+
ethyltoluene isomer	7	+	+	+	+	+	+	+
1,3,5-trimethylbenzene	3	+					+	+

* 2-h samples
** 48-h samples

(continued)

TABLE A-5. (concluded)

Chemical	# of times detected	SITE P2/L2*	P4/L3*	P3/L3*	P5/L1*	P6/L2*	P1/L1**	P5/L1**
tetraisobutylene	1		+					
methylcyclopentane	5			+	+	+	+	+
1,2-dichloropropane	1			+				
phenylacetylene	3		+				+	+
C_3-alkyl benzene isomer	2			+		+		
benzofuran	1			+				
biphenyl	1			+				
diphenyl ether	1			+				
C_7H_{16} isomer	3				+		+	+
1,2-dichloroethane	1				+			
alkyl acid	1				+			
hexamethylcyclotri-siloxane	3					+	+	+
octamethylcyclotetra-siloxane	2					+	+	
$C_{12}H_{26}$ isomer	1			+				
propylcyclohexane	2						+	+
dimethyldifluorosilane	1						+	
trichlorofluoromethane	1						+	
C_6H_{14} isomer	2						+	+
CS_2	1						+	
tichlorodeuteromethane	1						+	
1-butanol	1						+	
$C_{16}H_{32}$	1						+	

* 2-h samples
** 48-h samples

TABLE A-6. SUMMARY OF CHEMICAL IDENTIFICATIONS IN BEAUMONT (May 1979 Samples) ORNL**

Peak No.	Compound	# of times detected	T-3113 S-22	T-2313 S-21	T-3223 S-23	T-2233 S-17	T-3333 S-18	T-4143 S-25	T-3143 S-19	T-1343 Spike 5	T-4253 S-24	T-3253 S-20
2	dichlorodifluoromethane	1							+			
3	butane*	1		+								
4	isopentane	7	+			+	+	+	+		+	+
5	trichlorofluoromethane	10	+	+	+	+	+	+	+	+	+	+
6	n-pentae	4					+		+		+	+
7	acetone*	10	+	+	+	+	+	+	+	+	+	+
8	methylene chloride*	10	+	+	+	+	+	+	+	+	+	+
9	1,1,2-trichloro-1,2,2-trifluoroethane	1							+			
10	dimethylbutane	3			+			+	+			
11	2-methylpentane*	9	+		+	+	+	+	+	+	+	+
12	3-methylpentane*	10	+	+	+	+	+	+	+	+	+	+
13	perfluorobenzene	10	+	+	+	+	+	+	+	+	+	+
14	n-hexane*	9	+		+	+	+	+	+	+	+	+
15	methylcyclopentane*	9	+		+	+	+	+	+	+	+	+
16	diisobutyl ketone	1						+				
17	perfluorotoluene	10	+	+	+	+	+	+	+	+	+	+
18	1,1,1-trichloroethane	3							+		+	+
19	d_6-benzene											
20	divinylacetylene	4	+		+			+		+		
21	benzene*	10	+	+	+	+	+	+	+	+	+	+
22	cyclohexane*	9	+		+	+	+	+	+	+	+	+
23	2-methylhexane*	9	+		+	+	+	+	+	+	+	+
24	3-methylhexane*	10	+	+	+	+	+	+	+	+	+	+
25	dimethylcyclopentane	1						+				
26	trichloroethylene	4	+			+		+	+			

(continued)

* Also found on "blank" Tenax cartridges

** See Table 25 for sampling protocol

TABLE A-6. (continued)

Peak No.	Compound	# of times detected	T-3113 S-22	T-2313 S-21	T-3223 S-23	T-2233 S-17	T-3333 S-18	T-4143 S-25	T-3143 S-19	T-1343 Spike 5	T-4253 S-24	T-3253 S-20
27	hexamethyldisiloxane*	10	+	+	+	+	+	+	+	+	+	+
28	n-heptane*	10	+	+	+	+	+	+	+	+	+	+
29	methylcylohexane	10	+	+	+	+	+	+	+	+	+	+
30	ethylcyclopentane	2						+	+			
31	2,5-dimethylhexane	4	+				+	+	+			
32	2,4-dimethylhexane	5			+			+	+	+	+	
33	trimethylcyclopentane	2						+	+			
34	C_3-cyclopentane	2				+	+					
35	C_3-cyclopentane	1						+				
36	2,3,4-trimethylpentane	1							+			
37	toluene*	10	+	+	+	+	+	+	+	+	+	+
38	C_8H_{18}	2				+	+					
39	2-methylheptane*	7	+		+	+	+	+	+	+		
40	C_2-Cyclohexane	3		+	+			+				
41	3-methylheptane	8	+		+	+	+	+	+	+		+
42	dimethylcyclohexane	6	+	+	+	+		+	+			
43	tetrachloroethylene	6	+			+		+	+	+		+
44	C_2-cyclohexane	2						+	+			
45	n-octane*	10	+	+	+	+	+	+	+	+	+	+
46	chlorobenzene	2							+	+		
47	dibromopropane	1								+		
48	3-ethylhexane	2						+	+			
49	hexamethylcyclotrisiloxane*	10	+	+	+	+	+	+	+	+	+	+
50	2,5-dimethylheptane	1						+				
51	C_2-benzene	3				+		+	+			

* Also found on "blank" Tenax cartridges

(continued)

TABLE A-6. (continued)

Peak No.	Compound	# of times detected	T-3113 S-22	T-2313 S-21	T-3223 S-23	T-2233 S-17	T-3333 S-18	T-4143 S-25	T-3143 S-19	T-1343 Spike 5	T-4253 S-24	T-3253 S-20
52	C_2-cyclohexane	1						+				
53	C_2-benzene*	10	+	+	+	+	+	+	+	+	+	+
54	2,3-dimethylheptane	1						+				
55	2-methyloctane	8	+	+	+	+	+	+	+	+		
56	styrene*	1		+								
57	C_2-benzene	5					+		+	+	+	+
58	1,1,2,2-tetrachloroethane	1								+		
59	3-methyloctane	7	+		+	+	+	+	+	+		
60	C_2-benzene	7		+	+	+	+	+	+	+		
61	methylethylcyclohexane	6	+		+	+		+	+	+		
62	n-nonane	9	+	+	+	+	+	+	+	+	+	
63	C_3-benzene	2						+	+			
64	$C_{10}H_{22}$	1						+				
65	$C_{10}H_{22}$	1						+				
66	n-propylcyclohexane	1			+							
67	$C_{10}H_{22}$	1						+				
68	Benzaldehyde	10	+	+	+	+	+	+	+	+	+	+
69	$C_{10}H_{22}$	1						+				
70	phenylacetaldehyde	8	+	+	+		+	+	+	+		+
71	C_3-benzene	1										+
72	benzontrile	2					+			+		
73	C_3-benzene	9	+	+	+	+	+	+	+	+		+
74	C_3-benzene	6	+		+	+		+	+			+
75	C_3-benzene	9	+	+	+	+	+	+	+	+		+
76	$C_{10}H_{22}$	1						+				
77	$C_{10}H_{22}$	3	+		+			+				

* Also found on "blank" Tenax cartridges

(continued)

TABLE A-6. (continued)

Peak No.	Compound	# of times detected	T-3113 S-22	T-2313 S-21	T-3223 S-23	T-2233 S-17	T-3333 S-18	T-4143 S-25	T-3143 S-19	T-1343 Spike 5	T-4253 S-24	T-3253 S-20
78	C_3-benzene	5			+	+		+	+	+		
†79	phenol	5				+	+	+	+			+
80	dichlorobenzene	4				+		+	+	+		
81	n-decane	8	+	+	+	+	+	+	+	+		
82	C_4-benzene	4						+	+		+	+
83	4-methyldecane	1						+				
84	cresol											
85	C_4-benzene	1						+				
86	acetophenone	10	+	+	+	+	+	+	+	+	+	+
87	C_4-benzene	8	+		+	+	+	+	+		+	+
88	5-methyldecane	1						+				
89	C_4-benzene	3	+			+		+				
90	C_4-benzene	6	+		+	+		+	+			+
91	nitrobenzene	1								+		
92	n-nonanal	5	+			+	+	+	+			
93	C_4-benzene	3				+		+	+			
94	n-undecane	8	+	+	+	+	+	+	+	+		
95	C_4-benzene	4				+		+	+	+		
96	4-methylundecane	1						+				
97	5-methylundecane	1						+				
98	diethylmethylbenzene	2						+	+			
99	C_4-benzene	2	+					+				
100	naphthalene	7	+		+	+	+	+	+	+		
101	a silicon compound	5				+	+	+	+	+		
102	C_5-benzene	2						+	+			
103	n-decanol	5	+			+	+	+	+			
104	n-dodecane	8	+	+	+	+	+	+	+	+		

† Compounds added as spikes in spiked cartridges.

TABLE A-6. (continued)

Peak No.	Compound	# of times detected	T-3113 S-22	T-2313 S-21	T-3223 S-23	T-2233 S-17	T-3333 S-18	T-4143 S-25	T-3143 S-19	T-1343 Spike 5	T-4253 S-24	T-3253 S-20
105	a silicon compound	3				+	+	+			+	
106	C_nH_{2n+2}	1						+				
107	methylnaphthalene	6	+			+	+	+	+	+		
108	n-undecanol	1						+				
109	methylnaphthalene	5	+		+	+		+	+			
110	n-tridecane	7	+	+		+	+	+	+	+		
111	a silicon compound	5				+	+	+	+			
112	biphenyl	2						+				
113	butyl butyrate	6	+		+	+	+	+	+			
114	dimethylnaphthalene	2						+				
115	n-tetradecane	8	+	+	+	+		+	+	+		+
116	dimethylnaphthalene	2						+	+			
117	dimethyl isophthalate	3			+			+				
118	a phthalate	1						+				
119	n-pentadecane	5	+	+	+			+	+			+
120	C_nH_{2n+2}	1										+
121	diethyl phthalate	9	+	+	+		+	+	+	+	+	+
122	C_nH_{2n+2}	1										+
123	Tenax artifact	10	+	+	+	+	+	+	+	+	+	+
124	C_nH_{2n+2}	2						+	+			
125	C_nH_{2n+2}	1						+				
126	C_nH_{2n+2}	1						+				
127	dibutyl phthalate	4	+		+				+			
128	di-2-ethylhexyl phthlate	5		+			+		+		+	+
129	a phthalate	1		+								
149a	bromoform	1							+			

† Compounds added as spikes to spiked cartridges.

TABLE A-7. SUMMARY OF CHEMICAL IDENTIFICATION IN BEAUMONT AREA--ENVIRONMENTAL MONITORING SYSTEMS LAB, RTP (May 1979)

Compound	# of times detected	T1313	T2333	T2343	T3353	T2163	T2273	T2383	T2113	T2123	T2133	T2143	T2153	T2213	T1233	T2253
carbon dioxide	9	+	+	+	+	+	+	+		+	+					
propane	4	+				+	+				+					
2-methylbutane	12	+	+	+	+	+	+	+	+	+	+	+	+			
trichlorofluoromethane	15	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
acetone	15	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
pentane	15	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
methylcyclobutane	1	+														
2-methylpentane	15	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
3-methylpentane	13	+	+	+	+	+	+	+	+	+		+	+		+	+
hexafluorobenzene	13	+	+	+		+	+	+	+	+	+	+	+		+	+
hexane	15	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
methylcyclopentane	15	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
pentafluorobenzene	2	+		+												
benzene	15	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
cyclohexane	12	+	+	+	+	+		+		+	+	+	+	+		+
1-butanol	7	+	+	+			+	+						+	+	
2,4-dimethylpentane	2	+	+													
3-methylhexane	13	+	+	+	+	+		+	+		+	+	+	+	+	+
dimethylcyclopentane	9	+	+			+	+	+	+		+	+			+	
methylcyclohexane	15	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
ethylcyclohexane	6	+	+	+					+			+		+		
2,4-dimethylhexane	6	+	+	+		+						+		+		
trimethylcyclopentane	7	+		+				+		+	+	+		+		
trimethylpentane	2	+										+				
toluene	15	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
chloropentafluorobenzene	15	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

* See Table 25 for sampling protocol.

(continued)

TABLE A-7. (continued)

Compound	# of times detected	T1313	T2333	T2343	T3353	T2163	T2273	T2383	T2113	T2123	T2133	T2143	T2153	T2213	T1233	T2253
2,3-dimethylhexane	6	+	+	+		+						+	+			
2-methylheptane	11	+	+	+	+	+	+			+	+	+	+	+		
3-methylheptane	11	+	+	+	+	+	+			+	+	+	+	+		
dimethylcyclohexane	8	+	+	+				+	+		+			+	+	
methylethylcyclopentane	3	+	+									+				
n-octane	1	+														
chlorobenzene	3	+										+		+		
trimethylcyclohexane	7	+	+	+		+						+		+	+	
octanal	1												+			
xylene	7	+	+		+	+			+			+		+		
3-methyloctane	2	+	+													
cyclooctatetraene	4	+	+		+				+							
heptanal	5	+			+	+					+			+		
methylethylcyclohexane	4	+	+	+								+				
2,4-dimethylheptane	6	+	+	+	+	+						+				
methylethylbenzene	8	+	+	+	+	+		+				+		+		
benzaldehyde	14	+	+	+	+	+	+	+	+	+	+		+	+	+	+
propylbenzene	9	+	+	+		+	+	+		+		+		+		
benzonitrile	3	+			+		+									
trimethylbenzene	14	+	+	+	+	+	+	+	+	+		+	+	+	+	+
phenol	8	+	+	+			+	+	+					+		+
tetramethylhexane	4	+	+	+		+										
dichlorobenzene	6	+					+		+	+	+			+		
n-decane	1	+														
benzeneacetaldehyde	1	+														
2-ethyl-1-hexanol	5	+	+	+	+	+										
2,3-dihydroindene	3	+	+												+	
propenylcyclohexane	1															
1-phenylethanone	5	+	+		+	+						+				
methylpropylbenzene	4	+	+	+		+										

(continued)

TABLE A-7. (continued)

Compound	# of times detected	T1313	T2333	T2343	T3353	T2163	T2273	T2383	T2113	T2123	T2133	T2143	T2153	T2213	T1233	T2253
dimethylethylbenzene	7	+	+	+	+	+									+	+
decahydronaphthalene	1	+														
nonanal	10	+	+	+	+	+			+			+	+		+	+
n-undecane	1	+														
tetramethylbenzene	2	+				+										
1-undecane	1	+														
methylpropenylbenzene	2	+				+										
trichlorobenzene	2	+												+		
naphthalene	13	+	+	+	+	+	+	+	+	+	+		+	+	+	
decanal	8	+	+		+	+							+	+	+	+
dodecane	4	+		+					+				+			
methylnaphthalene	3	+	+												+	
tridecane	3	+		+					+							
trichloromethane	1													+		
isobenzfuranone	1	+														
n-alkane	5	+	+	+	+	+										
dimethylnaphthalene	1	+														
dimethylphthalate	5	+	+	+	+										+	
decacyclohexane	1	+														
substituted methylphenol	1	+														
phthalate	15	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
dibutylphthalate	6	+	+		+	+									+	+
ethoxyethene	1														+	
2-methylpropane	5		+				+	+		+		+				
1-butene	5		+			+	+	+				+				
butane	6		+			+		+	+		+	+				
methylbutene	1		+													
dichloromethane	6		+	+	+								+	+	+	
carbon disulfide	5		+	+	+									+	+	
1,1,2-trichloro-1,2,2-trifluoroethane	9		+	+	+				+		+	+	+	+		+

(continued)

TABLE A-7. (continued)

Compound	# of times detected	T1313	T2333	T2343	T3353	T2163	T2273	T2383	T2113	T2123	T2133	T2143	T2153	T2213	T1233	T2253
2-butanone	6		+				+	+	+	+	+					
pentafluoro(trifluoromethyl) benzene	1	+														
1,1,1-trichloroethane	7		+						+		+	+	+	+	+	
2-methylhexane	9	+	+	+	+			+	+		+	+		+		
heptane	13		+	+	+	+	+	+	+	+	+		+	+	+	+
2,5-dimethylhexane	2		+	+												
2,3,4-trimethylpentane	3		+	+		+										
4-methylheptane	1		+													
tetrachloroethene	8		+	+		+			+			+	+	+	+	
2,3,4-trimethylhexane	2		+									+				
hexamethylcyclotrisiloxane	11		+	+	+		+	+	+		+		+	+	+	+
2,6-dimethylheptane	2		+	+												
2,5-dimethylheptane	4		+	+		+						+				
3-methyloctane	2		+	+												
ethylbenzene	14		+	+	+	+	+	+	+	+	+	+	+	+	+	+
decane	4		+	+					+				+			
octamethylcyclotetrasiloxane	5		+		+			+					+	+		
2-methylpropylbenzene	1		+													
styrene	2												+		+	
ethylmethylcyclohexane	1													+		
ethenylethylbenzene	4		+						+			+	+			
diethylbenzene	1		+													
1-nonanol	1		+													
dodecanal	3		+	+		+										
n-alkene	1		+													
diethylphthalate	10		+	+	+	+	+	+					+	+	+	+
xenon	11			+	+	+	+	+		+	+	+		+	+	+
2-methyl-2-propanol	1			+											+	
2,3-dimethylbutane	3			+					+							

(continued)

TABLE A-7. (continued)

Compound	# of times detected	T1313	T2333	T2343	T3153	T2163	T2273	T2383	T2113	T2123	T2133	T2143	T2153	T2213	T1233	T2253
1,2-dimethylcyclopentane	1			♦												
2,2-dimethylhexane	1			♦												
1,2-dimethylcyclohexane	1			♦												
xylene isomers	5			♦									♦	♦	♦	♦
trimethylhexane	1			♦												
1,3,5,7-cyclooctatetrane	2			♦										♦		
2,6-dimethyloctane	2			♦		♦										
3,3,4-trimethylhexane	1			♦												
acetophenone	9			♦			♦	♦	♦	♦			♦	♦	♦	♦
undecane	6			♦					♦				♦	♦	♦	♦
tetradecane	1			♦												
pentadecane	1			♦												
limonene	1													♦		
perfluorobenzene	2				♦									♦		
perfluorotoluene	5				♦	♦			♦					♦	♦	
4-ethenylcyclohexene	1				♦											
branched alkane	1				♦											
undecanal	3		♦		♦	♦										
phosphoric acid--tributylester	1				♦											
2-pentene	1					♦										
2-methyl-1-butene	2					♦						♦				
2-methyl-1-pentene	5					♦		♦		♦	♦	♦				
trichloroethane	1									♦						
ethylcyclopentane	7					♦	♦		♦		♦	♦		♦	♦	
hexanal	2					♦					♦					
octane	9					♦	♦	♦	♦	♦	♦		♦	♦	♦	
chlorobenzene	3					♦			♦	♦						
2-methylpropylcyclopentane	1					♦										
2-methyloctane	1					♦										
nonane	4					♦	♦						♦		♦	

(continued)

TABLE A-7. (continued)

Compound	# of times detected	T1313	T2333	T2343	T3353	T2163	T2273	T2383	T2113	T2123	T2133	T2143	T2153	T2213	T1233	T2253
branched alkene	1					+										
1-dodecanol	1					+										
butylphthalate	1					+										
dichlorodifluoromethane	4						+	+		+	+					
pentene	1										+					
trichlorotrifluoroethane	1						+									
2-butanal	4						+	+		+	+					
ethylacetate	1						+									
octafluoromethylbenzene	5						+	+		+	+	+				
methylhexane	1						+									
ketone	2						+				+					
pentanal	1						+									
trichloroethylene	7					+	+			+		+	+	+	+	
dimethylhexane	3						+	+			+					
1-octene	2						+							+		
perchloroethylene	4						+	+		+	+					
alcohol	5						+	+		+	+	+				
alkylbenzene	7						+	+		+	+	+		+	+	
tributylphosphate	1						+									
carbon tetrachloride	6							+	+	+	+	+	+	+	+	
1-pentene	2								+						+	
propylcyclohexane	1													+		
chloroform	3								+				+		+	
cyclotetraene	1										+					
dimethyldisulfide	1								+							
1,2,4-trimethylcyclopentane	1								+							
1,2,3-trimethylcyclopentane	1								+							
ethylmethylbenzene	3						+								+	+
1-decanol	1								+							
1,2-dichloroethane	3									+	+			+		

(continued)

TABLE A-7. (continued)

Compound	# of times detected	T1313	T2313	T2343	T3353	T2163	T2273	T2383	T2113	T2123	T2133	T2143	T2153	T2213	T1233	T2253
dimethylheptane	3						+	+		+						
dimethylbenzene	4						+	+		+	+					
freon	1										+					
butene	2										+				+	
3-methyl-2-butanone	1										+					
4-methyl-1-hexene	1										+					
2,4,4-trimethylpentene	1										+					
2,2,4-trimethylpentane	2										+		+			
trimethyl-1-pentene	1										+					
trimethyl-2-pentene	1										+					
ethylmethylcyclopentane	1										+					
2-pentanol	1											+				
n-heptane	1											+				
1,2,3-trimethylbenzene	1											+				
2,2,3,3-tetramethylpentane	1											+				
2,2,3,4-tetramethylpentane	1											+				
ethyldimethylbenzene	1											+				
methylethylketone	1												+			
n-propylbenzene	2												+		+	
2,2-dimethylbutane	1													+		
2-methylpropanal	1													+		
2-methylpropenal	1													+		
1,3-dimethylcyclopentane	1													+		
ethylester benzoic acid	2													+	+	
isobutane	1														+	
cycloheptatrene	1															+
octafluorotoluene	2													+		+
aldehyde	5				+		+	+		+	+					
acetaldehyde	5								+		+	+		+	+	